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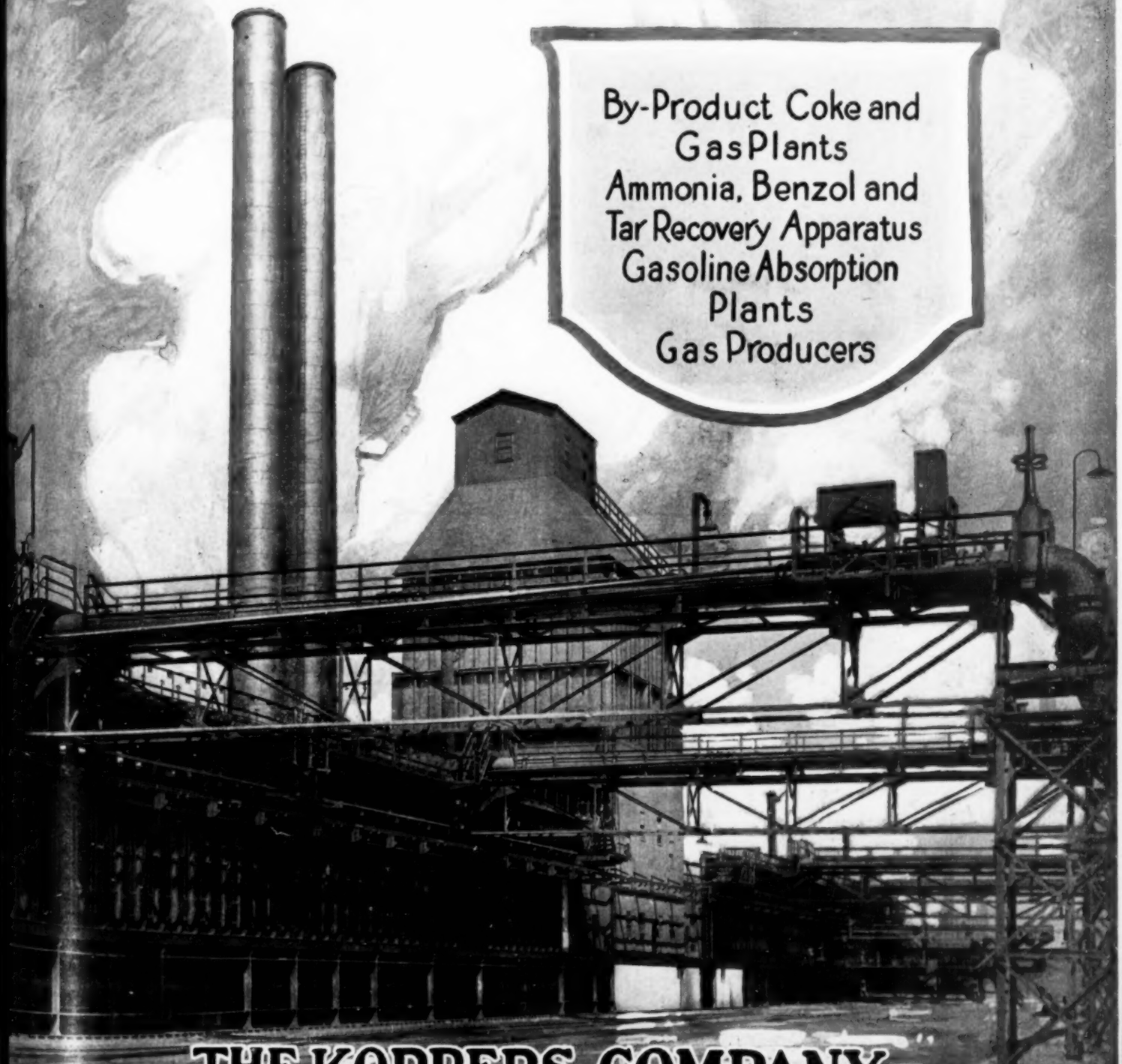

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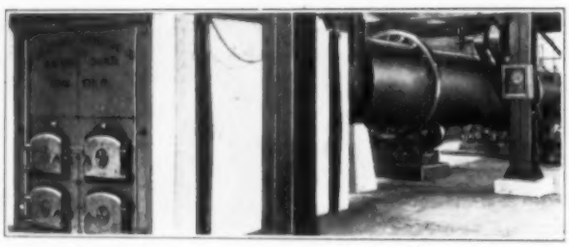

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Volume 23 — New York, August 25, 1920 — *Number* 8

Fall Conventions And Expositions

AS SUMMER approaches its end, and usually while the dog days are still upon us, we have to roll up our sleeves and get ready for the tumultuous month of September. It becomes a time for pleasant meeting and profitable discourse among men of science and technology. Many regard it as in agreeable post-vacation to attend the meetings. As editors we enjoy them also, but they can scarcely be construed as vacations. Editorial flowery beds of ease seem to be out of commission during September. Indeed, this year from the middle of August to the middle of October there is a continuous succession of professional gatherings in which chemists and metallurgists are interested. Outstanding features are the pilgrimage of the mining and metallurgical engineers to the Lake Superior country, the gathering of chemists in Chicago, the convention and exhibits of the steel treaters in Philadelphia, the Sixth National Exposition of Chemical Industries in New York, the meeting of electrochemists in Cleveland and of the Institute of Metals Division of the A.I.M.E. in Columbus. The dates of these gatherings are given elsewhere in our regular column devoted to that purpose.

Following our usual custom, we will herald the approach of the Chemical Exposition with a special issue, to be published Sept. 8. Literally speaking, months have been spent in its planning and preparation. Leaders in a score of industries have contributed their ideas of the progress which must be made in order to establish those industries on a truly scientific basis. As a consequence the issue will possess special character as a symposium by forward-looking specialists each of whom is in the front rank of his industry. At our invitation they have spoken freely and frankly of those things which must be done if rule of thumb is to be superseded by science. Rarely have we commented in advance upon the quality of material which we expect to publish, but in this instance the product of many minds is not only worthy of advance notice, but undoubtedly will be considered fit for preservation.

Small, but Quite Important

SCARCELY a week passes without announcement of some new fellowship or research award from endowment funds or other agencies interested in the reports of research. However, a large majority of these awards are for sums of $500 to $1,000 per year or less. Recently there was noted one case where six awards were made from a single fund, the largest being $500, the total less than $2,000.

It is rather strange that so much attention is given to these small sums, each of which amounts to less than the annual wage for a new office boy; but they suffice to hold post-graduate students for a year or two of research, or they provide some instructor or professor with enough funds to defray expenses of special apparatus and equipment.

The technical significance of these awards is very great, and they should be encouraged. Indeed, it is high time that our industries took a greater interest in encouragement of special research by the appointment of men at educational institutions or public laboratories that are particularly well fitted to work on their problems. Even though the companies do not realize handsomely on some of these investments, it is more than likely that the benefit from such support of special investigations will far exceed the average success in hiring the afore-mentioned office boy. Certainly there is no more promising way than this to use a small investment for research.

Contentment, Complaint And Present Progress

THE notion remains that a great many things are wrong industrially, financially and economically. It might be well to stop a moment and question whether there is not something wrong with the mirror of the mind that reflects the things observed. Perhaps we are taking things too seriously. It is quite true that progress is made through discontent. If one is contented with his condition he is not likely to strive to get somewhere else. Discontent with things over which one can have no influence, however, is a totally different matter.

The disposition to complain is obviously very strong. That is in part a product of the war and of the war-ending. During the war we saw certain things done by team work, by the people having a common purpose and we feel somehow that in these days everything ought to be righted by similar methods, but that is impossible because the single common purpose that existed during the war is lacking.

It certainly does seem as though discontent and the disposition to complain are greater than they should be or need be. For instance, there is "the transportation situation," which common talk would have it is almost indescribably bad. Transportation conditions have been improving rather steadily since the latter part of April. More freight cars were loaded in July than in June, and more than in July of last year. The quantity of transportation is not up to the requirements, and the quality is not what is desired, for when the freight does move it does not move as rapidly as it should. This is not the first time these things have occurred, but we are particularly sensitive on the subject now on account of the vast amount of public discussion of railroad matters.

Then there is coal. Many people talk as if there were a tremendous shortage, yet the fact is that production is very heavy and is probably in excess of current requirements, apart from the matter of stocking, which of course is desirable. The main thing about coal is the extremely high price. A ton of coal will buy a pair of shoes, whereas at one time it required three or four tons. The price of coal, however, is largely psychological, in that the market has been made by excited and more or less careless bidding, while the fact that coal is a particularly essential commodity has had an important influence.

Again, as to "labor" there has been much complaint. The supply of labor has been insufficient, but the matter can be put the other way, that there is an excess of desire to employ labor. Then there is complaint as to remuneration, that some vocations that require "years of preparation" do not furnish as good pay as the pick-and-shovel man gets, but the latter may rejoin that some people could prepare all their lives and then not have acquired the kind of back necessary for pick-and-shovel work.

One man tells us that money rates are too high, while another tells us that costs are so high capital will not seek investment. Both cannot be right. Everyone has his own complaint. Yet we have had the free play of forces for twenty-one months, since the Armistice, and really it is rather a strong demand upon us to admit that nothing has been adjusted or settled or equalized in that period. If collectively we have accomplished scarcely anything in nearly two years, a great many of us are likely to die before all the adjustments have been made. It would seem better to cultivate contentment with the circumstances forced upon us, to endeavor to complain less, and to make more effort at individual progress, taking things as they are, even though they are different from conditions before the war or conditions we expected to obtain after the war.

Where Are The Chemists?

UNDER the caption "How Best to Serve" appears an interesting editorial in the August *Journal of Industrial and Engineering Chemistry* which may be taken to express the attitude of officials of the American Chemical Society toward the movement leading up to the Federated American Engineering Societies. It is in answer to the question "Where are the chemists?" propounded in the June 23 issue of CHEMICAL & METALLURGICAL ENGINEERING, and is to the effect that the American Chemical Society actually is now functioning in public affairs by passing resolutions, by its officials' testimony before Congressional committees and advice to Government bureaus, and by the issuance of a news service recounting chemical facts in non-technical language. Past achievements convince the officers of the Society that they can continue to do good work all by themselves, without incurring the expense of affiliation in a national organization.

It is possibly due to obscure writing that the editor of the *Journal* has apparently missed our point. More simply stated, it is this: The new Federation is to be composed of engineering and allied technical organizations. Incontestably there is a big work to be done by it in furthering the public welfare wherever technical knowledge and training are involved. Where are the chemists? Such large numbers of them are engineers or engaged in work so closely related to engineering that it seems to us the officials of the Chemical Society are overlooking the inter-relationship of this new forward movement with chemical progress. A formal invitation to join has been extended to the American Chemical Society in common with all others of related interest and no doubt will receive careful consideration before an official reply is made.

Manufacture of Aluminum Castings

A SERIES of comprehensive papers by R. J. ANDERSON discussing the manufacture of aluminum: copper alloys starts in the present issue of CHEMICAL & METALLURGICAL ENGINEERING, in which debatable points in the practice are discussed in the light of experimental results. As may be known, the so-called No. 12 alloy (containing about 92 per cent aluminum and 8 per cent copper) and other light aluminum: copper alloys for sand castings are manufactured by two distinct methods: First, by adding solid copper to liquid aluminum in the required proportions by weight, and second, by charging a copper-rich alloy with the purer aluminum.

Many kinds of rich alloys are employed in nonferrous alloy metallurgy, including phosphor-tin, phosphor-copper, manganese: aluminum, manganese: copper, silicon: copper, nickel: copper, and copper: aluminum, for making fixed additions of elements in the manufacture of alloys. Similarly, in alloy-steel metallurgy, such well-known ferro-alloys as ferrotungsten, ferrochromium, ferrosilicon, ferromanganese, ferrovanadium, ferromolybdenum and other minor iron-alloys are employed for particular purposes. A rich alloy is employed for one or both of two purposes: First, for deoxidation or scavenging, and second, for making fixed additions of certain elements in the manufacture of alloys. From the metallurgical standpoint, rich alloys are generally preferred to commercially pure ingot because such alloys can usually be made with such melting points that they are readily incorporated in a bath of liquid metal. Furthermore, the liability of oxidation and slag losses of valuable metals is less.

Contrary to such general ideas ordinarily held by foundrymen about rich alloys, some foundries casting No. 12 alloy make the alloy by simply charging light copper punchings into a bath of liquid aluminum, hotter than usual, but still far below the melting point of copper. The copper alloys with the aluminum partly by diffusion and partly by solution and the rate of alloying is therefore dependent upon many conditions. A number of foundries in the United States employ this method exclusively, while many others decidedly oppose it on the ground that it is unsuitable for commercial practice. It certainly requires the bath to be superheated at some portion of its history, a practice which is quite liable to induce blow-holes and sponginess in the resultant castings. Some of the casting losses have been attributed to this method, it being claimed that, because of non-homogeneity of successive heats and even of a single ill-mixed melt, the castings are liable to run "hard and soft."

In view of the rapidly expanding use of aluminum castings, such a discussion of practice with recommendations for its improvement as will be presented by Mr. ANDERSON should be very interesting to metallurgists and foundrymen engaged in this work.

The Functions and Training Of the Chemical Engineer

MANY attempts have been made to define in a few words that branch of applied science which is known as chemical engineering. That such efforts have not been entirely successful is due largely to the fact that the profession is still in a formative stage of development.

The change in the training of the chemical engineer —from a mechanical engineer with a smattering of chemistry to a physical chemist with an engineer's point of view—has been brought about by a realization that chemical engineering is a distinct branch of engineering involving more than the mere adaptation of mechanical engineering principles to new environments. However, a clearer conception of many of the fundamental principles of the new science, of the chemical engineer's duties and of his true place in the industrial world will be necessary on the part of the instructing staffs in order that they may be qualified to train men for a profession which is destined to become one of the leading branches of engineering. That much remains to be done is evident from a recent statement that there are probably not more than six hundred qualified chemical engineers in the United States!

The question of chemical engineering education has received considerable attention lately, particularly in England, where the discussion on "What Is a Chemical Engineer?" at the May meeting of the Chemical Industry Club and the papers on "Functions and Training of the Chemical Engineer" by Lord MOULTON and Professor J. H. WEST of the Royal College of Science have brought out many interesting points. In order to encourage expressions of opinion or criticism from chemical engineers and others in this country, Professor WEST'S views are set forth in full elsewhere in this issue.

In this paper it is clearly pointed out that there are different kinds of chemical engineers and that the duties of a chemical engineer in plant work vary somewhat with the size of the plant and the complexity of organization of the technical staff. The statement that the daily routine connected with the operation of a smoothly running plant is not real chemical work or chemical engineering may come as a shock to some. While the man who is constantly on the alert for ways and means of increasing the efficiency of the process for which he is responsible may be pardoned for taking exception to this statement, does it not apply with full force to the man who is satisfied when he has filed away the day's data sheets and made the necessary entries on the production records?

In the light of this and similar discussions, we may summarize briefly the requirements for a chemical engineer. He must first of all be thoroughly familiar with all types of standard equipment for carrying out chemical engineering operations. A knowledge of the changes in chemical and physical properties of materials with varying temperature, pressure and concentration is also essential in considering the design or material of construction to be used in apparatus for a particular process. He should know how to calculate and apply quantitative flow sheets for heat and materials. The chemical engineer should appreciate fully the possible effects of change of scale upon the smoothness of a process developed in the research laboratory or in the small-scale plant. While he should not be expected to handle problems of a purely mechanical engineering nature, he should be sufficiently well versed in the fundamentals of this and allied engineering fields to be able to confer intelligently with experts in these branches. In this respect he should resemble the head of a large corporation who, although not an expert accountant, is able to tell his accounting department what is wanted and interpret its reports.

While all these phases of chemical engineering training are recognized today, it is doubtful whether a single educational institution could be found which is satisfied that its present course is so standardized that further improvement is unnecessary. Much progress will undoubtedly be made through suggestions from graduate chemical engineers who have learned through experience the weak points of the courses which they took. It might indeed prove profitable for departments of chemical engineering to keep in touch with their more experienced graduates for the purpose of strengthening their curricula through the constructive suggestions of these men, who are in the best position to interpret the needs of industry.

Auto-Catalytic Improvement

WHEN the Interstate Commerce Commission practically embargoed all other freight by giving open-top car priority to coal it did not at once appear that this remedy was to prove as quickly effective as now seems likely. The process of improvement in the fuel supply of the country, however, seems to have been catalyzed twofold by this arrangement. In the first place, coal, having priority, moves first, last, and all the time. In the second place, other raw materials and products requiring open-top cars do not move at all adequately to permit industrial activity on a full scale. As a consequence much construction work and many industrial activities, finding a shortage of cars, are unable to operate at all or must do so at part capacity. Their coal requirements are immediately reduced by this decrease in activity. The secondary effect of the order, therefore, is perhaps even more important in relieving the apparent fuel shortage in all markets than the primary relief. It is to be hoped, however, that this secondary effect will not progress too far and result in extreme curtailment of industrial activity. If it does we may well expect the cure to be almost as bad as the disease which the I.C.C. is treating.

Interrelation Of Sciences

THE untimely death of Surgeon-General WILLIAM C. GORGAS again reminds us of the important relation of one science to another. Without the wonderful work of this famous officer in the field of sanitation, much of the American success in cleaning up Cuba would have been impossible. His work as the chief sanitary officer in the Panama Canal Zone was, too, a fundamental contribution of greatest importance to this engineering project. Any who are disposed to exaggerate the importance of their own science can well consider this case and realize that it is only by adequate co-ordination of chemistry with engineering, chemistry with sanitation, chemistry with physics and mathematics, chemistry with biology and medicine, that the greatest accomplishments of the chemical profession may be achieved.

Readers' Views and Comments

Intercrystalline Brittleness

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have just been reading Technologic paper 158, of the Bureau of Standards, dealing with "A Peculiar Type of Intercrystalline Brittleness of Copper."* This is an interesting paper and there is food for thought in the following remark taken from page 5:

> It may be assumed, therefore, that only a relatively very thin skin has been rendered brittle by the electrolytic action; the properties of the entire rod have, however, been very profoundly changed.

At various times I have given some thought to the phenomenon of brittleness due to the action of sulphuric acid, on an iron bar, for example. It has often occurred to me that here is merely a surface action and yet, as is stated, the entire rod is "profoundly changed."

It seems inconceivable that any extensive alteration of the interior of the rod has occurred. Would it not then be possible that this brittleness is an electronic phenomenon, which might be described as a change in surface tension? In other words, may not the molecules of the metal be held together through surface action or tension, in effect binding the mass of material together, as the mass of molecules is held together in a drop of mercury?

While the placing of a bar of metal in a lathe and shaving it down does not alter this cohesion of the surface, yet some chemical action due to acid or alkali or to occluded gases might impair this skin effect, as has been so well described in circular 158 mentioned above.

Maybe we shall some day revise our views with respect to the forces which hold the particles of masses together.

A. C.

New York City.

Balanced Reactions in Steel Manufacture

To the Editor of Chemical & Metallurgical Engineering

SIR:—George F. Comstock has called my attention to a contradiction which I readily acknowledge in my paper "Balanced Reactions in Steel Manufacture," published in your issue of April 7, 1920. He writes:

"In the fifteenth line of the first column on this page it is stated that with much FeO in solution the ratio of CO_2 to CO will be great. But in the eleventh line from the bottom of this same column it is implied that this ratio should be higher with less FeO in solution. Is there some error here, or can you explain how these two statements can both be true? It seems to me that the 'CO_2 : CO ratio' in the tenth line from the bottom, and also in the little table, fourth line from the bottom, should really have been written 'CO : CO_2 ratio.'"

In the second paragraph of course the ratio CO_2:CO should read CO: CO_2.

Since writing that paper, however, I have found that the method of Goerens for estimating the gases in steels is liable to serious error. His method is based on fusing steels in a mixture of metals in which these gases do not dissolve and measuring the volume of gas which is evolved. The carbon in the steel sample cannot be dissolved either, and it rises to the surface of the molten mixture, where it reduces any CO_2 to CO, so that the total volume of gases is probably correct considered as an equivalent in CO, but the proportion of CO to CO_2 is entirely altered and no longer represents their relative ratios when present originally in the steel.

This vitiates any conclusions based on such results and makes my statement referred to one which may be true, but is not yet supported by any experimental evidence.

I would rather withdraw the paragraph entirely until figures to support it or disprove it can be obtained.

ANDREW MCCANCE.

Glasgow, Scotland.

*CHEM. & MET. ENG., vol. 22, p. 347 (Feb. 25, 1920).

Shattered Zones in Rails

To the Editor of Chemical & Metallurgical Engineering

SIR:—Editorial correspondence appearing in your issue of June 30, reviewing papers presented at the recent meeting of the American Society for Testing Materials, devotes some space to my observations concerning shattered zones in steel rails. If it is important to give credit to those who have advanced the subject, I should be inclined to state the matter differently than you have on page 1,189.

Messrs. Waring and Hoffammann at the very outset announced the presence of shattered zones in new rails; therefore it was not reserved for any one else to prove their pre-existence. What Waring and Hoffammann found, others have of course also found.

The high points in the investigation of shattered zones comprise:

1. Their presence in the heads and at junction of web and base in both new and used rails.
2. Hot sawed ends do not show shattered metal.
3. Certain medium hard rails have not yet been observed to display such zones, which, on the other hand, have been found in hard steel rails and wheels.
4. No foreign inclusions have been found in the shattering cracks.

Item 2 fixes the time of their formation in the stage of cooling after hot sawing. Curing by hot sawing is contrary to all known principles.

So many irrelevant and untenable conjectures have been made regarding transverse fissures that it has not seemed worth the while to discuss those on which there seems no basis of support. However, I think all tangible suggestions have been looked into. The reason for an interior origin of a fissure I think I stated clearly in 1911, arguing from a principle of mechanics.

JAMES E. HOWARD.

Washington, D. C.

$1,000,000 Louisiana Oil Plant

About $1,000,000 will be the cost of a plant for manufacturing essential oils to be built at Bogalusa, La., by the Essential Oils Co. of Philadelphia. The company has contracted to obtain its supply of wood waste from the big mills of the Great Southern Lumber Co. At least 500 men will be employed to operate the oil works.

Some Theoretical Principles of Alloying

A Discussion of Possible Applications of Such General Concepts as May Be Drawn From the Equilibrium Diagram, Heat of Alloy Formation, Thermit Reaction, Diffusion and Solution to Problems Connected With the Production of Aluminum : Copper Alloys in the Foundry

By ROBERT J. ANDERSON*

IN A detailed discussion of the manufacture of aluminum: copper alloys—except aluminum bronze—it is desirable to commence by a brief presentation of the equilibrium diagram for the Al : Cu system, as well as the effects of heat of formation, thermit reaction, diffusion, convection and solution. In the commercial preparation of metallic alloys the influence of various factors may be overlooked, but a thorough understanding of the fundamental metallurgical principles of alloying will permit corrective measures to be applied more readily when foundry troubles, due to the alloy, arise.

Equilibrium Diagram

The aluminum : copper series of alloys is of interest to the non-ferrous metal industry because it embraces many light castings, the rich alloys used for introducing copper into aluminum, and also the so-called aluminum bronzes. The curve shown in Fig. 1, after Carpenter and Edwards,[1] agrees well with that published by Guillet, except in minor details. With reference to this diagram foundrymen are interested mainly in the alloys containing 2.0 to 14.0 per cent copper, in those containing 33.0 to 60.0 per cent copper, and in those of aluminum: bronze composition, i.e., about 90.0 per cent copper and 10.0 per cent aluminum.

Three intermetallic compounds are known, viz., $CuAl_2$, Cu_9Al and Cu_4Al. An investigation with regard to the solubility of $CuAl_2$ in aluminum at different temperatures has recently been carried out by Merica[2] and his collaborators. These investigators have found that the solubility of $CuAl_2$ in aluminum decreases with decreasing temperature from about 4.0 per cent at 525 deg. C. to about 1.0 per cent at 300 deg. C., and it is less apparently at still lower temperatures. This means that the line dropped from *k*, in Fig. 1, to the base should not be perpendicular, but it should curve in accordance with the temperature-solubility of $CuAl_2$. Detailed discussion of the diagram is not necessary, nor will information as to equilibrium between the phases of the alloys be germane to the present article, but the diagram will be found useful for reference.

It may be emphasized, however, that not many alloys as commercially cast are in final equilibrium as indicated by their diagrams, and very fast or very slow cooling may be required to produce an alloy in true equilibrium. In fact, it is rather generally true that alloys are not usually in equilibrium unless actual precautions have been observed to insure this condition. The properties of alloys are influenced by this deviation, and the interpretation of phenomena which occur in alloys will be easier if this deviation from equilibrium is borne in mind.

Heat of Formation

When alloys are formed from their components the union takes place either with a development or an absorption of heat, but the possibility that other reactions may affect the heat change should not be overlooked. Few calorimetric determinations of the heat changes occurring in the formation of alloys have been made, but some are due to Person,[3] and Richards and Forbes,[4] and in the case of aluminum: copper alloys to Longuinine and Schukareff.[5] Direct estimation of the heat of solution (formation) of alloys is practicable only with metals and alloys of low melting points, and the difficulties involved in determinations of metals of high melting points are almost insuperable. The indirect method of determining the heat of solution consists in measuring the amount of heat developed when an alloy is dissolved in a liquid chemical reagent and then comparing the result so obtained with the heat calculated (for an alloy of the same chemical composition) from the observed heats of solution of the component metals dissolved in the same chemical reagent. If the measured heat of solution of the alloy is less than that calculated by the rule of mixtures, then the difference is said to represent the heat developed in the formation of the alloy. If the observed heat of solution is greater than that calculated the difference represents the heat absorbed. This method for determining the heat of solution of alloys was originally carried out by Hess, and has been employed by Galt and Baker in determinations of various alloys.

In the experiments of Longuinine and Schukareff the heats of formation were determined by measuring the heat of solution of aluminum, copper, and alloys of the metals in aqueous solutions of bromine and potassium bromide. These investigators found that an alloy corresponding to the formula Cu_2Al had the greatest heat of formation, but no such intermetallic compound exists; hence, the validity of their results is somewhat conjectural. The subjoined figures for the heats of formation of alloys of aluminum and copper are from the work of these investigators; most of the compositions given do not correspond to known intermetallic compounds.

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*Metallurgist, U. S. Bureau of Mines, Pittsburgh, Pa.

[1]Carpenter, H. C. H., and Edwards, C. A., "Eighth Report to the Alloys Research Committee on the Properties of the Alloys of Aluminum and Copper," *Proc.*, Inst. of Mech. Engrs., vol. 72, 1907, p. 370.

[2]Merica, P. D., Waltenberg, R. G., and Freeman, J. R., "Constitution and Metallography of Aluminum and Its Light Alloys With Copper and With Magnesium," *Bull.*, Amer. Inst. of Min. and Met. Engrs., July, 1919, pp. 1031-1049, CHEM. & MET. ENG., vol. 21, p. 551 (Oct. 29, 1919).

[3]Person, C. C., "Untersuchung über die latente Schemlzwärme," *Ann. der Physik.*, vol. 76, 1849 (II), p. 586.

[4]Richards, T. W., and Forbes, G. J., "Energy Changes Involved in the Dilution of Zinc and Cadmium Amalgams," Carn. Inst. of Washington, 1916.

[5]Longuinine, W., and Schukareff, A., "Thermal Examination of Some Alloys of Aluminum and Copper," *Arch. Sci. phys. Nat. Genève*, vol. 15 (IV), 1903, pp. 49-77.

Baker's experiments[6] indicate that the greatest heats of formation in the copper: zinc system occurred in the intermetallic compounds; it is to be expected that the same would be true of the aluminum: copper system.

Composition	Calories	Composition	Calories
Cu_9Al	123.5	$CuAl$	20.8
Cu_3Al	137.9	Cu_2Al_3	48.9
Cu_2Al_3	71.0	$CuAl_2$	—57.2

Entirely satisfactory figures for the heat of formation of various alloys of aluminum and copper are not available, but there is sufficient evidence to show that part of the rise in temperature which occurs when the two metals are alloyed is due to this phenomenon. It is a well-known fact that when aluminum is added to liquid copper there is an appreciable and immediate rise in temperature, but some disagreement has existed as to whether this temperature rise should be ascribed to heat of formation or to a thermit reaction between the aluminum and the oxygen in the copper.

Thermit Reaction

The possibility of reactions other than heat of formation contributing to the heat change observed when aluminum is added to liquid copper, or *vice versa*, has been mentioned. Ordinarily when aluminum is added to liquid copper there is a rise in temperature which, according to some observers, is from 40 to 250 deg. C., and often, according to others, sufficient to raise the temperature of the liquid melt to an intense white heat. The available evidence appears to indicate that this should not be attributed solely to heat of solution of aluminum in copper, as has been done,[7] but rather in part to the interaction of aluminum and copper oxide, or to aluminum and oxygen, or both. This is a strongly exothermic reaction. The reasons for the rise in temperature observed when aluminum is added to liquid copper have been gone into rather thoroughly in the discussion of the work of Carpenter and Edwards,[8] who found that when aluminum was added to liquid copper a very marked evolution of heat occurred; they did not find, on the other hand, any great rise in temperature provided the copper had been properly protected from oxidation. The conclusion was that the rise in temperatures should be attributed, not to the combination of aluminum and copper, but to that of aluminum and oxygen. Other investigators have found that if just sufficient aluminum is added to reduce all the copper oxide present in a melt of oxidized copper, subsequent additions of aluminum will not produce any considerable rise in temperature.

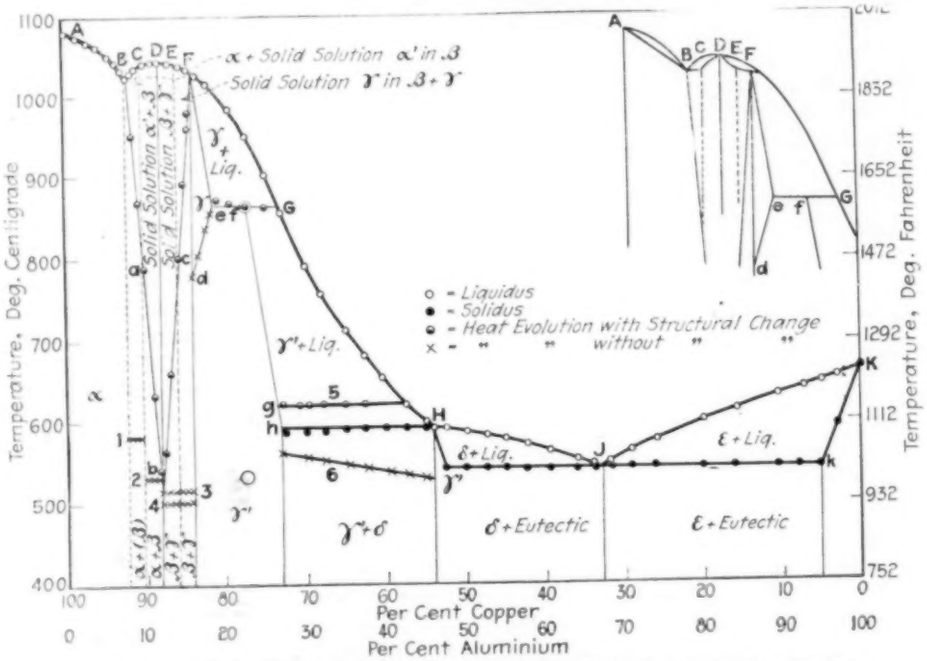

FIG. 1. EQUILIBRIUM DIAGRAM OF THE ALUMINUM: COPPER SYSTEM (AFTER CARPENTER AND EDWARDS)

[6]Baker, T. V., "The Thermo-Chemistry of the Alloys of Copper and Zinc," *Phil. Trans. Roy. Soc.*, vol. 196A, 1901, pp. 529-546.

[7]Curry, B. E., and Woods, S. H., "The Tensile Strengths of the Copper-Aluminum Alloys," *J. Phys. Chem.*, vol. 11, 1907, pp. 461-491.

[8]See footnote 1.

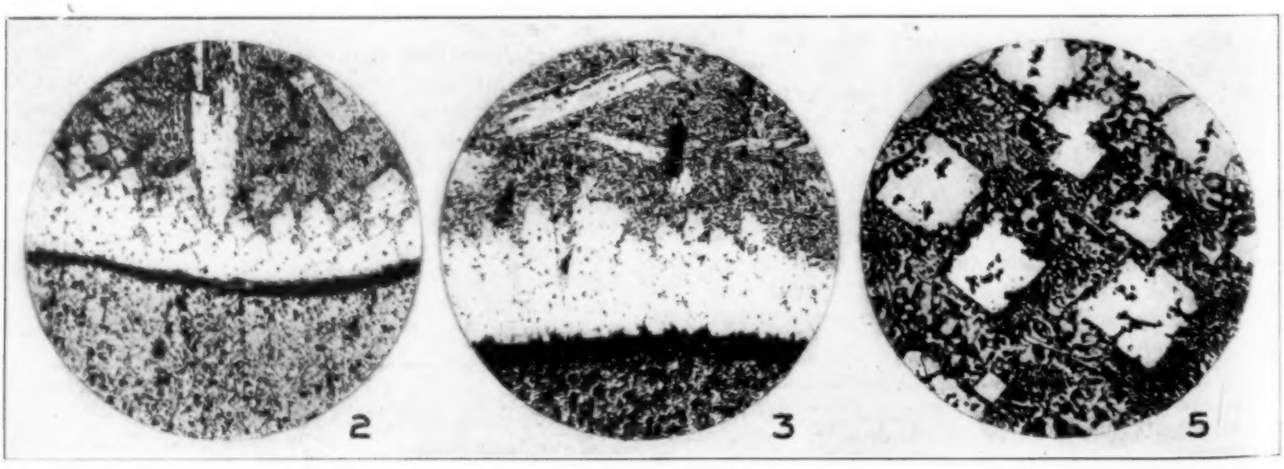

FIG. 2
Diffusion of copper into aluminum; etched with NaOH; × 50.

FIG. 3
Diffusion of copper into aluminum; etched with NaOH; × 50.

FIG. 5
$CuAl_2$ (light) and eutectic (dark) from one of the bands in Fig. 4 etched with $NH_4OH + H_2O_2$; × 200

Experiments carried out at the Bureau of Mines have shown that there is always a rise in temperature when aluminum is added to liquid copper, due to the heat of formation of the resultant alloy, but that the large rise in temperature described as a "white heat" is due mainly to the thermit reaction of aluminum with copper oxide. This large rise in temperature is very destructive of crucibles and iron pots in foundry practice, and it can be guarded against by melting the copper under a charcoal cover (if badly oxidized copper is used), by deoxidation with boron suboxide, or by otherwise preventing the oxidation of high-grade copper. The question of both heat of formation and thermit reaction in connection with the manufacture of aluminum: copper alloys is highly important as affecting dross losses.

FIG. 4

Micrograph of diffusion of copper into aluminum; etched with NH_4OH + H_2O_2; × 25.

There is plenty of evidence to show that the diffusion of metals in the solid state is a very general phenomenon, the classical experiments of Roberts-Austen[9] being particularly well known. That one solid metal can dissolve another has been shown by maintaining carefully surfaced pieces of two different metals in intimate contact for a long time. At atmospheric temperatures the diffusion is very slow, but it becomes more rapid at higher temperatures; and if a solid metal of higher melting point is placed in a liquid metal of lower melting point diffusion may be extremely rapid, depending upon the individual metals, the size and shape of the immersed metal, the relation of volume of liquid metal to surface of solid metal exposed, rate of agitation, amount of convection and the temperature.

From the practical standpoint diffusivity figures are not of much value, and furthermore they are liable to be in error when determinations are made of the diffusion of solid into liquid metals because of the effect of other factors such as convection, solution, and the changes occurring during alloying where the liquid metal is becoming progressively richer and richer in the solid metal. The object in calling attention to these factors is to indicate that they must be considered in the manufacture of alloys, but diffusivity figures in themselves are not necessarily applicable to foundry practice.

The process of diffusion may be conveniently observed (in the case of copper and aluminum) by placing a rod of solid copper in a crucible of liquid aluminum for a short time. On withdrawing the rod a fairly adherent coating will be found, consisting of a brittle silvery-colored alloy rich in aluminum. On analyzing the metal remaining in the crucible varying amounts of copper will be found, depending largely upon the time period of immersion of the copper rod and upon the temperature. If a microsection of the alloyed rod be examined, varying structures will be found, depending upon the thickness of the coating. Figs. 2 and 3 show the diffusion of copper into aluminum. The white areas above the black band separating the copper (below) and the aluminum: copper alloy (above) correspond to copper-rich compositions; the characteristic rectangular structure of $CuAl_2$ is shown, and the alloy becomes leaner in copper with increasing distance from the copper. These micrographs were taken on a sample obtained by suspending a cylinder of solid copper in liquid aluminum for a short time at a temperature below the melting point of copper and then freezing the aluminum with the copper in place. Fig. 4 is a view taken across an area of a diffusion sample obtained by freezing a copper rod in liquid aluminum after suspending it for five minutes at 700 deg. C. Starting with copper at the lower band in Fig. 4, the changes in microstructure from bottom to top of the photograph illustrate the variation in copper content (copper becoming leaner in the alloy with increasing distance from the copper rod). Fig. 5 shows the microstructure of one of the bands in Fig. 4; the structure corresponds to an alloy of about 55.0 per cent aluminum and 45.0 per cent copper in composition. The delta constituent, $CuAl_2$, appears light, since it is electronegative to the eutectic. The diffusion of metals may also be shown well by making small superposition ingots according to the method of Le Chatelier or otherwise. The principle of filiation,[10] enunciated by Le Chatelier in 1900, consists in the superposition of two metals in the liquid state in the order of their densities. The diffusion of one metal into the other makes it possible to obtain in a single specimen the entire series of alloys which can be formed by the metals. The series of alloys ranging from one pure metal to the other will be confined in a relatively restricted area, and the width of the area will depend upon the length of time during which one or both metals were liquid, upon the rate of cooling and upon the amount of agitation. While the preparation of superposition ingots serves a useful demonstrative purpose, it has a rather well-defined limitation in studying alloys. Fig. 6 shows the superposition of aluminum and copper, according to Le Chatelier.

FIG. 6

Superposition of aluminum and copper (after Le Chatelier).

[9]Roberts-Austen, W. C., "On the Diffusion of Gold in Solid Lead at Ordinary Temperatures," *Proc. Roy. Soc.*, vol. 67, 1900, pp. 101-105; and "Diffusion of Molten Metals," *Philosophical Trans. Roy Soc.*, vol. 187A, 1896, pp. 383-415.

[10]Le Chatelier, H., "Alloys by Superposition," *Proc. Inter. Asso. Testing Materials*, VI Congress. New York, 1912, II_{18}; and see also Broniewski, W., "Relation Between the Structure of Alloys and Their Electric Properties," *ibid.*, IX_8.

Convection currents in melting pots hasten the solution and diffusion of copper in aluminum—for example, in the manufacture of No. 12 alloy by charging copper punchings into liquid aluminum. There is more or less convection in any vessel heated over part of its external surface, and both diffusion and solution are more rapid with increased convection.

Convection is not to be confused with agitation, but the latter also hastens diffusion and solution. The importance of agitation by frequent stirring was early recognized in German practice, where charges of liquid aluminum and solid copper were stirred for several hours so as to insure thorough alloying. However, there is no necessity for stirring for such long periods.

Solution

Copper forms a compound, $CuAl_2$, with aluminum, and this compound has a limited solubility in aluminum in the solid state, the solubility varying with the temperature. The fact that copper may be alloyed with aluminum when solid copper is placed in liquid aluminum at a temperature considerably less than the melting point of copper is ascribed to the combined influence of solution and diffusion. Both factors are affected by temperature, and the rate of both solution and diffusion is more rapid at, say, 900 deg. C. than at 700 deg. C.

Production of Potash in the United States*

Incomplete returns thus far received by the Department of the Interior indicate that 110,309 short tons of crude potash salts, containing 30,899 short tons of available potash (K_2O), valued at $7,889,440, was produced in the United States by 73 firms in 1919.

In 1918 there were 128 firms operating plants, which produced 207,686 short tons of crude material containing 54,803 short tons of available potash. In 1917 only ninety-five firms were operating plants, which produced 126,961 tons of crude material containing 32,573 short tons of potash.

Plants Reopened

More than 60,000 tons of domestic crude potash material was in storage in January, 1919, and most of the plants were closed for a part of the year, some of them for the larger part. These conditions were brought about by the expectation of large imports of potash salts from abroad—an expectation that was not realized. Instead the stored material was sold, and many of the plants were reopened in the autumn, though some of them were again obliged to stop work because of shortage of coal.

The potash produced in the United States during the first three months of 1920, as reported to the Geological Survey from forty-three plants, amounted to 42,008 short tons of crude material containing 11,969 short tons of available potash, valued at $2,738,195.

Natural Brines

The only notable gain seems to be an increase in production from natural brines elsewhere than in western Nebraska. In 1919 six plants that produced potash from these brines made an output of 11,293 short tons of potash. In the first quarter of 1920, five plants working the same brines produced 4,104 short tons of potash, and if they continued production at the same rate during the entire year they would produce 16,416 short tons. The production of potash from cement kilns is proceeding at almost exactly the same rate in 1920 as in 1919, although there were only seven producers in the first part of 1920, against 13 in 1919.

Alunite was used in 1920 only in experiments made by companies that reported production of potash from this material in 1919.

The accompanying tables were compiled by M. R. Nourse.

*Statement by the U. S. Geological Survey of output in 1919 and in the first quarter of 1920.

POTASH PRODUCED IN THE UNITED STATES IN 1919, CLASSIFIED ACCORDING TO SOURCE

Source	No. of Producers	Production of Crude Salts (Short Tons)	Available (K_2O) (Short Tons)	Percentage of Total	Total Value	Percentage of K_2O in Crude Product
Natural brines:						
Nebraska lakes	8	35,837	9,045	29.3	$1,889,416	22–28
Other brines	6	32,385	11,293	36.5	2,875,908	11–50.5
	14	68,222	20,338	65.8	$4,765,324	.....
Alunite	5	6,594	2,293	7.4	683,055	8–52
Dust from cement mills	13	11,750	1,258	4.1	272,090	2.5–60
Dust from blast furnaces silicate rock and kelp	7	2,200	250	0.8	62,035	3–32.5
Molasses distillery waste	6	8,498	2,792	9.0	801,331	14–39.8
Steffens waste water	8	12,459	3,616	11.7	1,078,291	9.5–44.5
Wood ashes	20	586	352	1.2	227,314	60
	73	110,309	30,899	100.0	$7,889,440	.....

POTASH PRODUCED IN THE UNITED STATES IN THE FIRST THREE MONTHS OF 1920, CLASSIFIED ACCORDING TO SOURCE

Source	No. of Producers	Production of Crude Salts (Short Tons)	Available (K_2O) (Short Tons)	Percentage of Total	Total Value	Percentage of K_2O in Crude Product
Natural brines:						
Nebraska lakes	7	23,337	5,859	49.0	$1,280,819	22–28
Other brines	5	9,726	4,104	34.3	936,161	15.8–56
	12	33,063	9,963	83.3	$2,216,980	.....
Alunite, blast-furnace dust and silicate rock	3	1,336	565	4.7	174,912	9.8–52
Dust from cement plants	7	4,015	314	2.6	44,246	2.3–35
Wood ashes	14	108	65	0.5	36,671	60
Steffens waste water	3	1,870	440	3.7	118,666	12–42
Kelp and molasses distillery waste	4	1,616	622	5.2	146,720	26–51
	43	42,008	11,969	100	$2,738,195	.....

British Columbia Plans to Develop Its Iron Deposits

Plans to establish an iron and steel industry on the Pacific coast of British Columbia are being considered by Canadian interests. Deposits of magnetic iron ore are known to exist in the territory, together with the necessary flux and fuel. The Canadian Collieries, with its extensive coal fields on Vancouver Island, its coke ovens and iron-ore-bearing properties, is probably better situated than any other corporation to undertake this important project.

Already a group of engineers has been in consultation with the government authorities, to establish ways and means of erecting a 300-ton furnace. It is felt that there is enough demand for iron and steel in the district to take care of the output of such a furnace, and if this demand does not materialize, the establishment of railroad car and equipment shops in this section would solve the difficulty.

Government co-operation is assured in the form of bonuses for pig iron in British Columbia produced from local ores. For a 300-ton plant this would amount to about $1,000,000 yearly.

Progress in the Byproduct Coke Industry*

Description of the Modern Practices and Methods Exemplified in the Ford Plant—Coke-Oven Gas—Market for Byproducts—Ammonium Sulphate—Light Oil and Gas Enrichment—Tar

BY C. R. BELLAMY

THE year 1919 is memorable to the coke industry in the United States, for in it for the first time the production of byproduct coke exceeded that of beehive coke. This fact is at the same time of vital importance to all our industries. For as Floyd Parsons has expressed it, "The industrial prosperity of leading civilized nations depends upon their utilization of fuels and metals." In this statement is found the real significance of the change from beehive to byproduct coke predominance. Better utilization of coal, our basic fuel, is the beginning of real conservation.

Our byproduct coke-oven industry, with close to 11,000 ovens in operation at this time, is one of huge dimensions, and the modern coking plant is one of the great achievements of chemical and mechanical engineering. The results of a modern plant show what progress has been made. The high yields indicate improved methods, while the uniform yields indicate the extent to which operation is under control. A better knowledge of the factors that are essential to good results, coupled with the ability to control these conditions, is the feature of our best plants. Before going into details concerning operation data of one of the most modern plants let us briefly trace the growth of this industry and the progress that has kept pace with this growth. In the writer's opinion, the expansion of the byproduct coke oven has been marked by three distinct periods, which with the attributed causes are given in order of sequence:

1. Recognition by the steel industry that byproduct coke could be made that was superior to any beehive coke.

2. Recognition by the gas industry of the fact that in the byproduct coke oven was its opportunity for development on the lines of real efficiency and economy.

3. General conviction that the market for benzol, ammonia and tar was firmly established and able to absorb all possible production from coke ovens.

The first period was realized by overcoming the old-time prejudice of the blast-furnace operator and then seeking his co-operation in determining what constituted a satisfactory metallurgical coke. To illustrate this, the work of the Semet-Solvay Co. in conjunction with that of different blast furnaces is most interesting. For years this company made daily all the tests of which it had knowledge, such as specific gravity, porosity, shatter, loss in CO_2, size of pieces and structure. These tests, accompanied by investigation and research at ovens and furnaces, finally led to the fixing of certain definite standards, and by strict adherence to these standards byproduct coke has come to sell at a premium. Factors which are considered essential to the production of high-grade furnace coke are:

1. Proper preparation of the coke in all respects, including size.

2. Uniformity of the coal mixture used in the manufacture of coke, thereby producing coke of reliable chemical composition.

3. Uniformity of heating of the charges in the oven, thereby controlling the physical structure of the coke.

Coke-Oven Gas

The commercial value of the surplus gas from byproduct coke ovens was slow to be appreciated, and it was only about eight years ago that any general recognition of this value was apparent. Since then the progress in this direction has been so remarkable that today the byproduct oven looms up as the real solution to the problems confronting our public gas utilities. Very many of the large cities east of the Mississippi River are now supplied with coke-oven gas straight or mixed with water gas. The literature of the gas industry as concerns manufacture is now largely devoted to the byproduct oven and it has given us many valuable papers upon this subject.

In this field, again, co-operation has meant success. Joint investigation by the two industries concerned has made it possible for the modern byproduct plant to deliver a coal gas that will pass the most exacting specifications as to B.t.u., candle power and purity. And this gas can be produced so economically that no other process can compete. Some of the factors that make the production of such high-grade gas possible are:

1. Proper mixture of proper coals.
2. Tight ovens.
3. Proper regulation of pressure in ovens and in the hydraulic mains.
4. Proper carbonization temperatures.
5. Constant and reliable observations.

Market for Byproducts

During the world war the byproducts from coke ovens were found to be indispensable. Because of their exten-

FIG. 1. PUSHER SIDE OF OVENS, LIGHT OIL PLANT IN FOREGROUND

*Read before the American Institute of Chemical Engineers, Montreal, June 29, 1920.

sive application at that time the merits of these products are now appreciated to the extent that they are just as indispensable in times of peace. As soon as this market was established the coke and gas industry was quick to avail itself of the fact and the growth of the industry has been very rapid since then (1914).

The byproducts are the same now as before the war, although at that time the Semet-Solvay Co. was the only commercial producer of light oils. Improved methods have, however, resulted in much better yields of these products. This improvement consists chiefly in the control of operating conditions. There is an old coke-oven axiom, "Temperatures, incident to the so-called

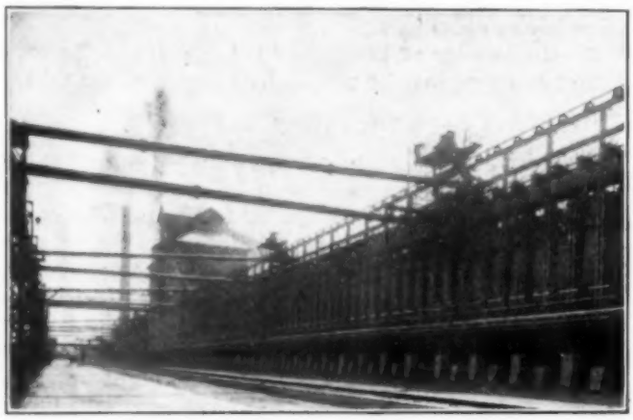

FIG. 2. PUSHER SIDE OF BATTERY

high-speed operation, seriously affect the yields." Under modern practice this has been changed so that it can be said that temperatures properly related to the speed of operation do not seriously affect the yields. And likewise the other determining factors are now under regulation.

The Ford Plant

The modern practices and methods are well exemplified by the plant of the Ford Motor Co. at River Rouge, Mich., which is considered by many to be the finest byproduct coke-oven plant in the world.

Early in May it was my good fortune to study this plant for several days, and in this article I want to discuss certain features of the equipment, operations and results which particularly impressed me. The data given here are those of actual results. The yields are especially important, not only because they are high but because of their uniformity through varying speeds of operation.

This plant was completed and put in operation in October, 1919. Its chief function is to supply a high-grade metallurgical coke to the Ford blast furnaces. At the same time a contract with the Detroit City Gas Co. calls for 10,000,000 cu.ft. of 18 cp. and 600 B.t.u. gas per day. Thus these ovens constitute a combined coke and gas plant and must maintain the highest quality in both products. To do this the speed of operation must not give rise to conflicting factors, but rather all conditions must be properly co-ordinated to the speed of operation. Due to the unsettled conditions in the coal and railroad industries this plant has not had any really fast operation. In fact, very few plants have operated at full capacity during the period under discussion. The operation, however, has been performed at somewhat varying speeds, so that a study can be made of the effects, if any, of such changes.

The Ford plant consists of 120 standard Semet-Solvay regenerator coke ovens, built in two batteries of equal size. Each battery is independent of the other in regard to control of operation. The gas direct from the ovens is received by a double hydraulic main, one main taking the rich gas given off during the first period of carbonization, while the second main receives the remaining lean gas. This separation of gas during carbonization is performed in the usual manner—that is, by valves which are easy to open and close and which can be reversed when and as often as desired. The rich gas and lean gas are treated exactly alike up to the benzol scrubbers. Here the treatment is different and after passing through these scrubbers the two gases travel different paths, the lean returning to the ovens, the rich gas after enrichment and purification going to the city. The apparatus and equipment used to handle the gas is built in triplicate, one unit for the rich gas, one for the lean, with the third and middle unit as a spare. This spare unit is so connected to the system that it can take care of either the rich or lean gas as necessary. The importance of this feature is that repairs, apparatus cleaning and inspection do not cause inefficient or irregular operation. Having a spare system of byproduct recovery apparatus and a spare for all essential machinery used on the ovens, this plant is enabled to operate on a time-table schedule. Every oven is pushed at the exact time scheduled, the schedule being observed with railroad precision. This regularity of operation which is essential to the production of a satisfactory quality of surplus gas, where high standards are required, means also that the load on byproduct apparatus is uniform and favorable for maximum byproduct yields. In the table of results it will be noted that the initial rich gas has

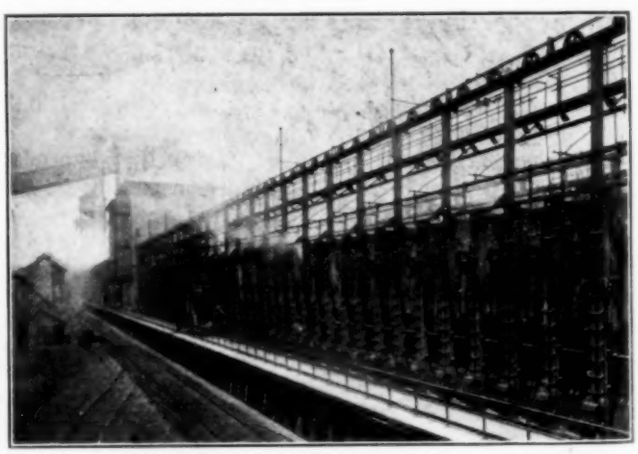

FIG. 3. DISCHARGE SIDE OF OVENS AND COKE WHARF AT LEFT

been produced without an appreciable variation in B.t.u. value for over three months.

Each oven is designed for a charge of fifteen tons of pulverized coal and to carbonize this coal in any period from 16 to 30 hr. as desired. The capacity of the oven and the uniform coal charges are points that are worth emphasizing. At the Ford plant not only is the daily average charge per oven uniform but there is very little variation in the weights of coal charged in the different ovens. The regularity maintained in this operation is shown by Fig. 4, which gives average daily weight of coal charged per shift. This curve is posted in the foreman's office and closely watched by all three shifts.

The size of an oven is determined by the amount of coal that it can successfully carbonize. Size has so far been an index to the progress of the industry, increasing capacity resulting in lower unit costs. This because the plant, exclusive of ovens, and force required for operation and maintenance of complete plant are fixed and independent of oven capacity. That is to say, the power plant, byproduct recovery apparatus, piping and other machinery will be practically the same for any given plant regardless of the capacity of its ovens, while

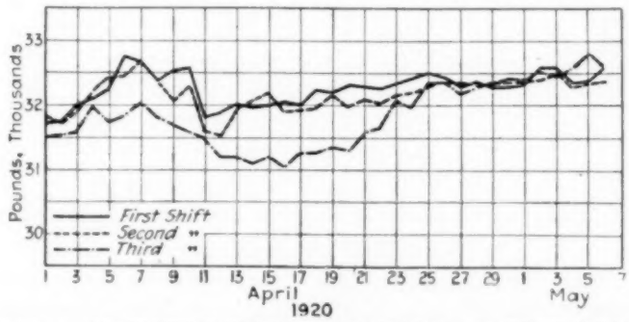

FIG. 4. OPERATING DATA, FORD PLANT, AVERAGE NUMBER OF POUNDS OF COAL CHARGED PER OVEN PER SHIFT

the number of workers will be almost the same. The increased tonnage due to larger capacity of units will therefore give its yields at little or no cost of production.

Operating on an 18 hr. schedule the Ford plant has a daily capacity of 2,400 tons of coal. Were these ovens of 12-ton size the capacity of the plant on a like schedule would be 1,920 tons. In a 30-day month this would mean that the 15-ton unit plant would carbonize 14,400 more tons of coal than the smaller unit plant. The yields from this increased tonnage would be about 10,000 tons of coke, 345,000 lb. of ammonium sulphate, 45,000 gal. of light oil, 115,000 gal. of tar and 86,000,000 cu.ft. of surplus gas. Figuring that the value of the coke recovered would cancel the cost of the additional coal and cost of producing byproducts there would be a net gain something like this:

345,000 lb. $(NH_4)_2SO_4$ @ 5c. per lb	$17,250
45,000 gal light oil @ 15c. per gal	6,750
115,000 gal. of tar @ 4c. per gal	4,600
86,000 M. cu.ft. gas @ 20c. per M	17,200
Total monthly gain	$45,800

It is true that the initial cost of the larger plant would be greater, but the returns just enumerated would yield handsome interest on the additional capital required.

Ammonium Sulphate

The recovery of ammonia at the Ford plant is performed by the Semet-Solvay direct ammonium sulphate process. This process, which represents over eight years' extensive experience with direct methods, marks a notable achievement in chemical engineering. The process is direct in procedure, practically automatic in operation and produces a pure white salt. The high yields which are obtained are readily explained by the direct manner in which the gas is treated and by the control of the ammonia reactions.

In the first place, each oven is properly filled with coal, as previously described, so that favorable conditions exist at the start. The coke-oven gas upon leaving the ovens travels a short distance from the hydraulic main and then passes through a two compartment cooler. From these coolers an exhauster (Curtiss steam turbine) takes the gas and sends it under pressure through a tar extractor of the P. & A. type, then through another two-compartment apparatus, called an economizer, from which apparatus it goes to the saturator. The gas leaves the saturator minus its ammonia, is freed of acid and then cooled for benzol recovery. This is the full journey of the gas so far as ammonia is concerned.

The gas enters the two-compartment cooler at a temperature slightly above 80 deg. C. In the first compartment the temperature is lowered about 30 deg. C. and in the second compartment it is brought down to 30 deg. C. This temperature of 30 deg. C. has been found to be the critical one for proper condensation in conjunction with minimum effort for subsequent heating. The cooling medium is a weak ammonia liquor, which, traveling over grids counter-current to the gas, is very efficient. The strength of this liquor is maintained so that only a minimum amount of NH_3 will be absorbed in the cooling of the gas and the condensation of the light tars. Separation of the tar and liquor is effected in the coolers, which have a large base, by means of decantation. The tar is drawn off from the bottom and runs to a decanter, while the liquor entering the suction pipe of the pump at a higher point is sent through cooling coils and then back to the gas cooler. Each compartment of this cooler has its own circulation. A special constant level overflow device maintains a constant volume of liquor for circulation by carrying away an amount equivalent to that added by condensation and absorption of ammonia. Ammonia thus held in solution has to be

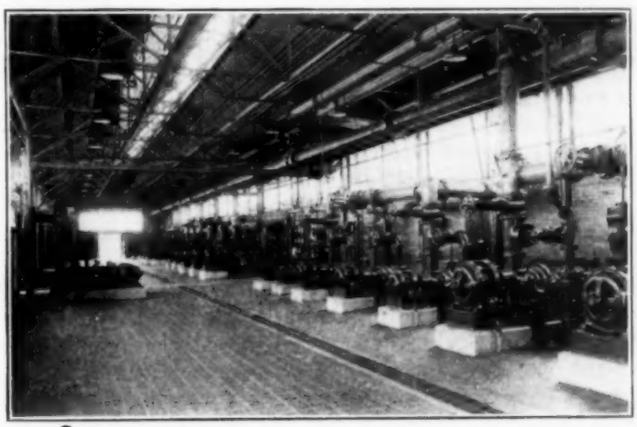

FIG. 5. BYPRODUCT PUMP HOUSE

liberated by steam and lime in a still, from which it returns to the gas at inlet to saturator. With this exception the process is "direct."

The Curtiss steam turbine, whose primary function is that of an exhauster, serves in a threefold manner, for in pumping the gas it is at the same time an efficient tar extractor. Due to heat of compression, the gas leaves the turbine at 50 deg. C., or about 20 deg. C. higher than it entered. Thus the turbine is exhauster, tar extractor and heater combined. The P. & A. tar extractor removes the last trace of tar.

From the tar extractor the gas goes to the economizer, where it is brought in contact with the liquor of condensation from the hydraulic main to pick up and restore to the gas some of the water of condensation and free ammonia; the gas leaving the economizer is at the proper temperature for the sulphate reaction.

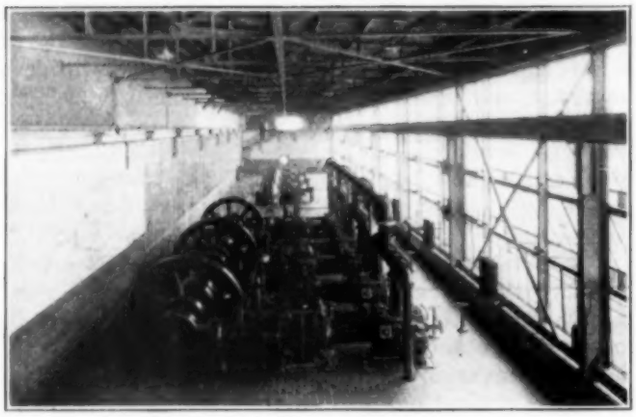

FIG. 6. EXHAUSTER AND COMPRESSOR ROOM

The clean gas at 70 deg. C. enters the saturator, which contains sulphuric acid of 45 g.p.l. strength, that is, nearly normal acid. The saturated acid is lifted by means of an air ejector into a sludge tank in which crystallization takes place and the unsaturated acid drains back to the saturator. The salt goes to a centrifugal, where it is first dried and then washed with water. It is dumped from the centrifugal into barrows, weighed and conveyed to a large hopper, from which it is handled into storage by an overhead crane.

A small stream of fresh acid (60 deg. Bé.) flowing into the saturator keeps the strength at the proper mark. With acid of the proper strength and gas at the proper temperature objectionable crystal formation does not take place in the saturator. The small amount of crystals that are bound to form on metal surfaces are not permitted to accumulate. Once each day for a few minutes the acid strength is built up to 125 g.p.l. and thus all crystals are dissolved and a clean saturator is maintained.

The results obtained at the Ford plant are indicative of the progress that this process makes in ammonia recovery. The high yields as shown in the table of operation data were obtained from a coal mixture containing 20 per cent low volatile coal. From straight high volatile coal even higher yields may be expected.

As important as the yield of a byproduct is the cost of production. The unit cost is the test that tells the tale. During the month of April this plant produced over 1,500,000 lb. of $(NH_4)_2SO_4$ with an operating force of five men per 8-hr. shift and one foreman. This foreman also has charge of the light oil plant.

One of the most essential points in a direct ammonia sulphate process is clean gas. Practically all the treatment through which the gas passes preparatory for entrance to saturators is made with the one purpose of obtaining clean gas. Upon the success of this treatment the purity and color of the sulphate depend. Hence the vital question is, "How clean is the gas?" To determine this the filter paper method devised by the Semet-Solvay Co. has been found very valuable. The apparatus, which is called the tar camera, needs little description other than that given in Fig. 7.

An apparatus is here shown by means of which a known volume of gas can be drawn through filter paper and a comparison made of the color produced on the filter paper to indicate the degree of purification of the gas. As usually performed two filter papers are used for each test to absorb the tar from 8 l. of gas.

The amount of tar carried by the gas should be reported by comparing these filter papers with a photographic scale, similar to that used in any color comparison quantitative test. Or where great accuracy is required the determination is made by weighing the filter papers before and after the picture.

This apparatus can also be used for the determination of H_2S in gas. In this test the filter papers used are, of course, moistened with lead acetate.

FORD OPERATING DATA 1920

Actual Results of Semet-Solvay Direct Ammonium Sulphate Process

Date	Dry Coal Charged, Tons per Day	Coal Moisture, per Cent	Sulphate Yield, Com. Lb. per Ton	Per Cent NH_3 in Sulphate	Acid Consumed per Lb. $(NH_4)_2SO_4$	Per Cent Free Acid in Sulphate	Per Cent Moisture in Sulphate
January.....	1,813	5.2	25.7	25.01	1.07	0.169	2.25
February.....	1,813	4.4	26.5	24.94	1.01	0.135	2.42
March.....	2,030	4.0	25.9	25.00	0.95	0.125	2.46
April.....	2,022	3.5	25.8	24.99	1.00	0.112	2.16
May.....	1,911	3.5	26.8	25.00	1.02	0.151	1.84

Surplus Gas

The method employed for the preparation for sale of the surplus gas from the coke-oven plant is determined by the specifications which the gas has to meet. The general trend in the industry is toward the elimination of candle-power specifications and lowering the calorific value of the gas required for cities. Canada has now permanently adopted a standard of 450 B.t.u. and no candle power. Only three of the larger cities of the United States still cling to a high-candle-power specification. This development is in direct line with the conservation of the natural resources of the country and is to the economic advantage of both producer and consumer of gas. It is no longer good economy to enrich gas with benzol to produce candle power when the requirements for motor fuel are rapidly outstripping the supply. Money spent for enrichment of gas is practically all wasted, as, with very few exceptions, the

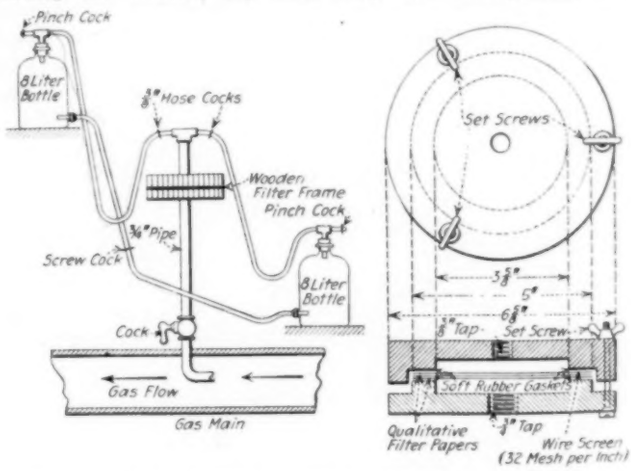

FIG. 7. TAR CAMERA. LEFT—GENERAL LAYOUT OF APPARATUS. RIGHT—FILTER FRAME

consumer derives no benefit therefrom. The purchase of special coals or the separation of the rich gas from the lean, or any other operation involving cost, to increase the calorific value of manufactured gas brings no benefit to the consumer, who must, of course, pay for this increased cost, and the Public Service Commissions and gas manufacturers should join in the determination and adoption of the standard of calorific value which permits a million B.t.u. to be delivered to the consumer at the lowest price. Of course, gases containing high percentages of nitrogen, like producer

gas, are not to be considered in this discussion. This argument is illustrated by the following table, which shows the B.t.u. per cu.ft. in the various gases when mixed with the theoretical amount of air required for their combustion. This mixture of gas and air is what the consumer actually burns, so it is clear that any of these gases, when properly burned with the correct percentage of air, will give the same results.

	Natural Gas	Oil Gas	Retort Gas	Coke-Oven Gas	Carburated Water Gas	Blue Water Gas
B.t.u.	91	93	91.7	91	92	88
Flame temp., deg.	1,852	1,915	1,896	1,892	1,914	1,928

So the real point of interest to the consumer is which gas can be furnished to him at the lowest cost per million B.t.u.

In several cities, however, the legal standards still require the delivery of gas of high candle power and high B.t.u. content, and the gas from the Ford plant has to meet the standard of 18 candles and 600 B.t.u.

Light Oil and Gas Enrichment

The recovery of light oil at the Ford plant is so closely related to the enrichment of gas that these two subjects can well be treated together. As is usual in plants where surplus gas of high calorific and candle power specifications is sold to public utilities, the rich and lean gases follow parallel but separate paths throughout the byproduct recovery system. Up to the benzol scrubbers they are treated exactly alike, but from here on the treatment differs.

It is a comparatively simple matter to obtain large yields of surplus gas that will pass the average B.t.u. requirements, which have recently been lowered in most states. In such cases it is possible to remove practically all the light oils from the gas, and if so the rich and lean gases can be treated alike in the recovery of benzol, or the gases may be treated without separation, if the calorific standard permits. In being freed of its light oil the surplus gas is lowered in B.t.u. value, but at the same time it has all of its naphthalene removed. This treatment gives a gas suitable for distribution and, if separated, of 590 to 600 B.t.u. value. Such a gas meets the requirements of many cities which retain a high calorific standard, but it will not pass a high candle-power specification, and where such exists it is necessary to produce a very high-grade gas. Proper oven operation will yield such a gas, after which this quality must be maintained and delivered to the city without loss. For distribution it is essential that this gas be free of $C_{10}H_8$, but it cannot stand the loss of any other illuminant. Of course, all the light oils could be washed out, freed of naphthalene and then used to enrich the gas to the proper mark. A high-grade gas would result, but the process would be rather inefficient and very expensive. The correct way is to take out the $C_{10}H_8$ without removing the light oils. This is accomplished ratus and methods. The procedure is as follows:

The lean gas, upon leaving the saturator, is cooled and at the Ford plant by the standard Semet-Solvay appa- enters the benzol scrubber at a temperature of about 25 deg. C. In this tall tower it is completely stripped of its light oil content by being washed with an absorption oil of like temperature. This absorption oil, straw oil or ordinary gas oil, is circulated counter-current to the gas flow and leaves the scrubber containing about 2 per cent of light oil.

The rich gas, upon leaving the saturator, is likewise cooled and enters a benzol scrubber at the desired temperature. Here it is washed by one-half of the benzolized absorption oil from the lean scrubber, the other half of this oil going directly to the light oil still. The

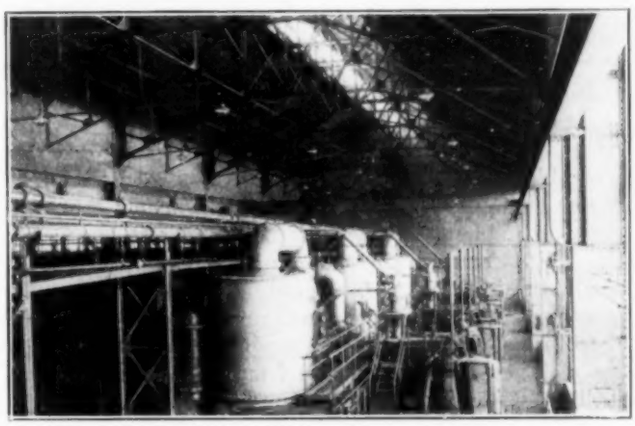

FIG. 8. DIRECT SULPHATE APPARATUS

small circulation of benzolized oil absorbs all the $C_{10}H_8$ from the gas, also some toluol and xylol, but removes very little benzol. Thus the gas is purified of $C_{10}H_8$ without serious loss of other illuminants. The drop in B.t.u. and candle power, due to this treatment, is so slight that very little enrichment is necessary. According to the latest figures, only 0.027 gal. of light oil is vaporized per 1,000 cu.ft. of gas to bring the gas above specifications.

The most important feature of this surplus gas operation is the uniformity of results. Not only has the surplus gas yield been high, as will be noted from table of operating data, but it has been a yield of high-grade gas. That is the important fact, for the yield of surplus gas means nothing until compared with the quality. Furthermore, this yield has been almost constant in amount through the varying speeds of operation. Every day from Jan. 1 to June 1 the gas company has received practically 10,000,000 cu.ft. of gas from these ovens—gas that has always been above the standard. This gas has been produced and delivered with scarcely any varia-

FORD OPERATING DATA, 1920

Surplus gas, light oil and tar yields

Date	Dry Coal Charged, Tons per Day	Total Gas per Ton of Coal, M. Cu.Ft.	Gas to City per Day, M. Cu.Ft.	Candle Power Initial Rich Gas	Candle Power Gas to City, Official	Light Consumed for Enrich., Gal. per M. Cu.Ft.	B.t.u. Gas to City	Light Oil Produced, Gal. per Ton	True L.O. Yield, Gal. per Ton	Tar Yield, Gal. per Ton
January	1,813	10.53	9,959	12.83	18.08	0.09	636	2.32	2.65	6.02
February	1,813	10.39	10,135	13.82	18.17	0.14	647	2.35	3.74	8.09
March	2,030	10.63	10,004	14.05	18.14	0.10	648	2.61	3.76	8.84
April	2,022	10.50	9,906	14.27	18.21	0.10	638	2.43	3.68	8.64
May	1,911	10.04	10,518	15.12	18.12	0.05	643	2.42	3.45	8.51

tion in B.t.u. or candle-power values. The uniformity of these results appears remarkable in comparison to those obtained only a few years ago, but shows what can be expected from modern ovens with advanced knowledge and methods for regulation. The maximum gas recovery which is here shown is one reason also for the uniformly high sulphate yield.

A description of the light oil still is hardly necessary, as it is of the standard Semet-Solvay type. No fractionation is made, but the light oil is purified, washed and redistilled and sold as motor fuel. A satisfactory motor fuel consisting of benzol, toluol and xylol, mixed with an equal amount of gasoline, has the following distillation results:

Boiling Point, 71 deg. C. Sp.gr. @ 16 deg. C., 0.811

Off at, Deg. C.	Per Cent	Off at, Deg. C.	Per Cent
85	10	114	60
88	20	130	70
91	30	154	80
96	40	195	90
103	50	218	95

Loss on distillation, 2 per cent. Residue, 3 per cent.

During the switchmen's strike there was a gasoline shortage in Detroit which caused some worry but little or no inconvenience, due to the fact that the Ford plant was able to release 300,000 gal. of purified light oil for motor fuel. Tank wagons from the various companies came to a plant for oil and distributed it throughout the city. Thus a serious situation was averted.

The light oil that is recovered by the method described comes mainly from the lean gas. The true yield is therefore the sum of the oil produced and the oil left in the rich gas. This total would mean a high commercial yield, and one that would be possible wherever the gas specification was below 600 B.t.u., with no candle-power requirements.

Tar

The old-time problem, "What is to become of the tar?" has apparently been solved satisfactorily. With the enormously increased supplies the market has kept pace and today tar is selling at a decidedly higher price, but yet somewhat below its true value. Tar lends itself readily to a variety of uses, many of which are just beginning to be appreciated. The Ford experience affords an interesting illustration in this respect.

The original boiler equipment contained eight 400-hp. Wickes boilers, arranged for gas firing. The demand for gas was so heavy that tar was utilized in its place most satisfactorily and at a decided saving over coal, the value of tar being taken at 5c. per gal. When using tar the pump at the storage tank is run continuously, so that there is a constant circulation sufficient to meet the highest peaks and yet allow excess tar to be bypassed from the discharge to the suction line. In order to keep the tar hot the discharge line is wrapped with two 2-in. steam lines and the tar reaches the boilers at a temperature of 90 deg. C. At that point superheated steam is used to raise the temperature to 100 deg. C. and by means of steam injectors delivered to the tar burners.

When the price of fuel oil became almost prohibitory the Ford company began experimenting with tar to take the place of oil in the heat treatment of forgings, etc. This worked out so satisfactorily that the company expects shortly to be using 15,000 gal. of tar per day, which will do the same amount of work as the 25,000 gal. of fuel oil formerly used. Part of this is due to the higher efficiency of the tar and the remainder to improvements in operation. This tar is as it comes from the byproduct coke plant, no further refinements being necessary.

In conclusion, I wish to acknowledge the assistance given by A. A. Kelkenney, superintendent of the Ford coke plant, in preparing the operation data and curves shown here and to express my appreciation of the courtesies and assistance given me by his organization.

The Solvay Co.
Indianapolis, Ind.

Progress in Low-Temperature Carbonization of Coal

Developments in the low-temperature carbonization of coal are taking place in the United Kingdom, and a number of important industrial concerns have entered into contracts to secure the products of this process. It is understood that three plants are to be operated in the execution of existing contracts, which contemplate the combustion of bituminous coal by low-temperature methods in order to conserve the potentially rich constituents, such as motor spirit or gasoline substitute, fuel oil, sulphate of ammonia, and gas. Among the industries which have recently made agreements to utilize the byproducts of the process are an electric power company, a large municipality, a firm of steel manufacturers, and a general manufacturing firm.

The exponents of low-temperature carbonization estimate that 1,000,000 tons of coal will be consumed annually under existing contracts and that plants for the exploitation of the process will supply, in addition to 7,000 million cubic feet of gas, the following products:

Products	Use	Approximate output for Sale per Annum
		Gal.
Motor spirit	Motor cars, aeroplanes	3,000,000
Fuel oil	Suitable for Navy and ship fuel	16,000,000
		Tons
Smokeless fuel	Domestic fuel	700,000
Sulphate of ammonia	Fertilizers and high explosives	9,000

It is understood that the process has been patented in this country and abroad. Although it appears that any important industry normally consuming large supplies of bituminous coal may utilize the process, the greatest development in its future exploitation will be through the erection of large plants in the colliery districts, where the constituents can be economically extracted and distributed.

Canada's Paper and Pulp Exports

The Canadian Government statistics for the year ended March 31, 1920, give the total value of the pulp and paper exports of the Dominion as $104,636,901. This is the first time that these figures have reached the hundred-million mark. In 1919 the exports were valued at $82,569,680, and in 1918 at $63,344,143, the totals for the three years being made up of:

Paper and pulp	Year ended March 31 1918	1919	1920
Paper and manufactures of	$37,723,251	$47,862,909	$63,253,419
United States	32,768,348	38,621,265	50,367,339
United Kingdom	710,516	1,040,857	4,813,577
Chemical pulp	19,133,813	30,226,856	33,000,063
United States	16,171,096	26,256,265	25,550,882
United Kingdom	1,603,738	611,399	3,212,119
Mechanical pulp	6,487,079	4,479,915	8,383,419
United States	6,487,079	4,418,555	5,765,871
United Kingdom	.....	3,033	1,802,281
Total	$63,344,143	$82,569,680	$104,636,901
United States	55,426,523	69,296,085	81,684,092
United Kingdom	2,314,254	1,655,289	9,827,977

The 1920 paper exports included 14,272,513 cwt. (713,625 long tons) of newsprint, valued at $53,203,792, constituting more than 50 per cent of the total. The United States took 12,553,349 cwt. (627,667 long tons), valued at $46,809,178.

Legal Notes

By Wellington Gustin

Decision on Patents of Cottrell and Speed

The United States Circuit Court of Appeals, Ninth Circuit, has reversed and remanded, with directions, the decree of the District Court, dismissing the infringement suit of the Petroleum Rectifying Co. brought against the Reward Oil Co. The suit was based on alleged infringement of the Cottrell and Speed patents, Nos. 987,115 and 987,116, for a process and apparatus for separating and collecting particles of one liquid suspended in another. The first-numbered patent covers the process and the second is for apparatus by which the process is carried out.

Specifications of Patent Involved

The specifications in the invention say:

"There is a large class of oils that cannot be economically freed from water without distillation. These are largely oils in which the water is in very small globules, often less than one-thousandth of an inch in diameter, and behaving as if surrounded with a membrane-resisting coalescence of the drops . . . Many natural petroleums as taken from the wells contain from ½ to 50 per cent of water in the form of small drops (i.e., emulsions), and after being allowed to stand for months still hold a great proportion of the water in suspension."

Judge Gilbert in his opinion says: "The specifications go on to say that the inventors had found that, when these emulsions are subjected to the action of high potential electric charges in the manner thereinafter described, they are rapidly de-mulsified, the water settling to the bottom of the vessel, collecting into large masses, which can be readily withdrawn, leaving the oil dry.

"The process involved in the invention, as shown by the specifications, is substantially this: Oil loaded with water in the form of minute globules is passed between two electrodes separated at a proper distance, the electrodes being connected to a source of electricity of sufficiently high potential to create between the electrodes an electrostatic field or field of electric strain, which will cause the minute globules of water to conglomerate and coalesce until they become so large that they will settle out from the oil by gravity. For present purposes it is sufficient to quote the first claim:

" 'The improvement in the art of separating and collecting particles of one liquid suspended in another, which latter is essentially a non-conductor of electricity, consisting in bringing the material to be treated between electrodes connected to a source of electricity of sufficient voltage to produce coalescence of the suspended particles in such wise as to cause the rapid separation of the two liquids throughout the body of the mixture, and at the same time prevent the coalescing globules from forming complete chains, short-circuiting the electrodes.'

Contention of the Appellee

"The appellee (Reward Oil Co.), operating under a patent issued Oct. 26, 1915, No. 1,158,253, for 'Process of Dehydrating Oil,' removes the moisture from oil by passing the oil between electrodes connected to a source of electricity of sufficient voltage to cause the suspended particles to coalesce in such wise as to produce rapid separation of the two liquids throughout the body of the mixture. But the appellee contends that it does not infringe the appellant's (Petroleum Rectifying Co.) patent for the reason that it does not prevent the coalescing globules from 'forming complete chains, short-circuiting the electrodes.' Therein is the whole ground of controversy in the present suit. In both processes there are the electrodes, the sufficiently high voltage to produce coalescence of the moisture, and to separate the same from the oil. The only question is whether the operation involves different methods of electrical action. In the application for the McNear and Bowles patent reference was made to the appellant's patent as follows:

" 'Said patentees (Cottrell and Speed) relied upon the electromotive force only to break down the oil partitions between the water globules, and took especial pains to prevent short-circuiting between the electrodes, and, indeed, their inventions consisted wholly in the prevention of short-circuiting. We have discovered that far better results are obtained by relying, not upon electromotive force, but upon heat as an agent to produce coalescence between the water globules, this heat being produced by the passage of the very large electric current which is produced by short-circuiting, the amount of heat being such as to convert water globules in the path of the current into steam, and by said conversion breaking the electric current in said path.'

"This fanciful explanation of the effect of the current in the appellee's process may be pardoned in view of the fact that neither the patentees of that patent nor any expert witness was able to say just what does occur in the mass of the fluid when under treatment in either process. The theory that in the appellee's process the water globules are by the electric current converted into steam is not established by evidence, and is discredited by the appellee's expert witnesses. The defense of non-infringement, therefore, rests upon the appellee's contention that in the appellant's process there is no passage of electric current from one electrode to another, and that the dehydration of oil accomplished therein is the result of the maintenance of an electrostatic condition in the fluid between the two electrodes, whereas in the appellee's process the dehydration is accomplished by the passage of currents of electricity from one electrode to another. In other words, according to the appellee, it is essential to the appellant's process that short-circuiting be avoided, while it is essential to the appellee's process that short-circuiting be produced. We are led, therefore, to the inquiry what is short-circuiting as referred to in the appellant's claims, and what is the proper construction of the appellant's claim where it provides for a source of electricity of sufficient voltage to prevent the coalescing globules from forming complete chains short-circuiting the electrodes."

Conclusions of the Court

In concluding this inquiry the court says:

"The term 'short-circuiting' in the appellant's claims, if susceptible of two meanings, should be given that which the specifications show it was intended to have, if that meaning is not repugnant to the plain and clear terms used. Cottrell and Speed were the first to discover the process of dehydrating oil by electricity. Their invention went into large and extensive use. For

a time it was used by the appellee under a license. Prof. Cory states that so far as he knows it is a pioneer invention. It should receive a fairly liberal construction that will uphold rather than destroy. The construction given the term 'short-circuiting' by the court below is, we think, erroneous. What the inventors meant by the term was a total short-circuiting, and not the succession of minute short-circuits snapping from one electrode to another, whereby dehydration is accomplished in both the appellant's and the appellee's process. The claims of the appellant's patent must be read in the light of the invention as disclosed in the specifications. It appears therefrom that the inventors recognized the essential value of the formation of chains between the electrodes and the instantaneous disruption of the chains by electric current, and at the same time the necessity of maintaining the potentiality of the main current, and that it was to express that necessity that they inserted in the claims the caution against such short-circuiting of the current as to interfere with the process. They realized that the momentary passage of short currents between the electrodes would not 'short-circuit' their current in the sense in which they used that term in their claims."

Further the court said that it was not essential that patentees should either understand or set forth the scientific principle on which the patented process operated. It quoted from another decision where that court said:

"It may be that the inventor did not know what the scientific principle was or that knowing it, he omitted, from accident or design, to set it forth. That does not vitiate the patent. He sets forth the process or mode of operation which ends in the result, and the means for working out the process or mode of operation."

OPINION OF EXPERT WITNESS—VIEWS OF THE COURT

Prof. Cory, expert witness for the appellee, was of the opinion that chains were formed in appellant's process, the theory of which, as stated by the court, is that, if the voltage is sufficiently high, chains are formed and a current flow instantaneously occurs, which demolishes the chains, whereby the flow is arrested. That a variation in the current does occur in practice is shown in appellant's specifications, which state that when the proper electromotive force is applied the ammeter will show "irregular variation" in the current, or "occasional momentary variation."

Further, the appellee contended that the extensive use and great utility of appellant's process is owing to the use of the rotating type of treater disclosed in the Cottrell and Wright patent assigned appellant, and not involved in the present suit, and that the inventions disclosed in the patents in suit are not operative.

This contention the court held to be not sustained by the record. In the first, said the court, the fate of appellant's process patent is not linked with that of its apparatus patent. "No process patent is in theory either helped or harmed by the excellence or worthlessness of the disclosed apparatus by which it is illustrated." (255 Fed., 83.) In the instant case the court said: "Again, the evidence shows that it is not true that the first apparatus was a failure. A 'treater' constructed under the apparatus patent in 1909 was in use for several years. The evidence is that it required readjustment, and that it was not perfect in operation, and that some three years later the appellant resorted to the use of treaters with revolving electrodes as disclosed in the Cottrell and Wright patent, and thereby increased the efficiency of the process from 15 to 25 per cent. No defects in the process patent, therefore, can be predicted upon defects in the apparatus patent, and the fact that the first apparatus was defective is no reason for denying protection to either the patented process or the apparatus. . . . If, as we have found, the appellee uses the appellant's process it is immaterial that by improvements in structure of its apparatus, the appellee has so increased the efficiency of its machine that it marks a distinct improvement upon the appellant's apparatus."

Purchaser Should Use Good Faith in Making Resale of Goods Not Up to Specifications

Judgment for Smith, DeMacedo & Co., Inc., Philadelphia, against Swift & Co. was recently affirmed by the Supreme Court of Pennsylvania. Swift & Co. had sold to the former company thirty-four tons of oleostearine, an article represented to be suitable for the same uses and to comply with the specifications set forth for stearic acid. It was to be resold and shipped for use in Portugal. Upon arrival there it was found the commodity did not conform to the specifications, and the customer declined to accept the shipment.

With concurrence of Swift & Co. the shipment was directed to be sold for the best price obtainable. Thereupon, the court said, it became the duty of Smith, DeMacedo & Co., Inc., through its agent, to exercise good faith, reasonable judgment and diligence in making a resale. If this were not done and the first seller sustained a loss thereby, the buyer cannot enforce the rule that the damages would be the difference between the value of the goods at the time of delivery and the value they would have had if they had answered the warranty (specification set forth on order) at the time and place of delivery.

There was evidence to show that a resale was necessary, and that owing to the lack of shipping facilities, the article could not be sold elsewhere than in Lisbon. The law is that in such cases the loss must be minimized by the holder of the goods and he will be held responsible for any negligence in reducing loss to the product.

Evidence as to the price obtained on the resale, introduced to show the measure of damages, such damages to the brokers being the difference between the contract price and the market price of the product, was objected to on the ground that the witness testifying knew nothing of market conditions. But the court said the sale took place through an experienced broker for the very best price obtainable, and it was not shown that such sale lacked good faith, nor that the circumstances under which the sale was made were calculated to produce the best price obtainable or to procure the best market price, nor for the reason that the evidence was but the opinion of the witness nor because it did not appear that Smith, DeMacedo & Co. used reasonable efforts to secure the best obtainable price.

That the witness had no knowledge of the market condition was not availing since the price obtained through a fair sale would establish a market condition for that sale, and certainly would be the best price obtainable as agreed upon by the parties in ordering the resale. Of course, when such sale is unfair and damage results because the sale is below the market price, this latter price becomes important in establishing the seller's loss. Judgment for the brokerage company was affirmed.

Cure of Flakes by Proper Heat Treatment

An Account of a Heat-Treatment Practice Evolved for Heavy Nickel Steel Forgings Which Reduced Flaky Test Bars to 15 Per Cent of the Total, Based on the Idea That Most Flakes Are Caused by Internal Strains in the Metal

By C. S. CROUSE*

THINKING that the problems met and solved in evolving a standard practice in one plant might possibly prove of assistance to others, I have outlined the following observations which were taken over a period of about eight months and cover the time from the start of treating, through the experimentation period, up to and including the time when a standard practice was developed.

Furnace Equipment

The heat-treating plant under observation was equipped with seven vertical, electric resistance type furnaces furnished by the General Electric Co., each one having six rows of nichrome heating elements or ribbons, the upper three and the lower three rows acting as independent units. Power was furnished by a three-phase, 220-volt alternating current. The furnaces (shown in Fig. 1) were cylindrical in shape, being made of firebrick with a boiler plate shell, and a capacity of nine type A or eight type B forgings, which types will be explained below. The forgings were hung in a circle from a supporting spider (Fig. 2) so that their outer sides were within a few inches of the heating ribbons. Attached to the spider, by means of a heavy round bar, was an eye so that the whole charge might be handled as a unit by means of an overhead crane.

The charge and spider were in turn supported in the furnace by being suspended, by means of a square, flat plate under the eye, from two movable eye-beams which in turn rested on rails on either side of the furnace pit (see Fig. 1). After the charge was placed in the furnace the top was closed by rolling two semi-circular covers into place, these covers being made of brick incased in a casting. After the covers were closed there was very little loss of heat by radiation, thus making for a high heat efficiency.

The furnaces were further equipped with an automatic temperature control furnished by the Leeds & Northrup Co., which operated as follows: There were twelve holes in the sides of the furnace arranged in three rows spaced at thirds around the circumference, the holes in each row being spaced about equally from top to bottom of the furnace. These holes were for the purpose of inserting iron-constantan thermocouples through the wall of the furnace to actual contact with the forgings, all the holes, however, not being in use at any one time. There were also two other holes so situated that a couple might be inserted to get the nichrome ribbon temperature, one couple getting the temperature of the upper three rows of ribbons and the other that of the lower three rows.

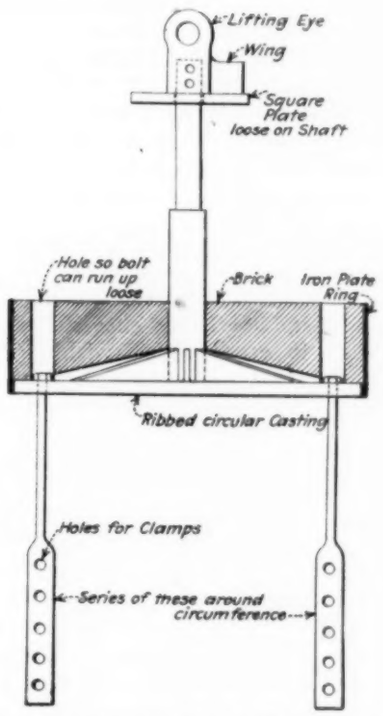

FIG. 2. SKETCH OF FORGINGS SUPPORTING SPIDER

Each half of the furnace was furnished with a recording pyrometer which plotted both the ribbon and the forging temperature in that part of the furnace and, being set for any temperature, automatically threw the current off and on so as to maintain that temperature. In addition there were extra thermocouples placed in each furnace and connected to a Leeds & Northrup multiple point recorder, this arrangement acting as a check on the other.

All cold junctions were carried up to the instruments in the pyrometer room, where they were automatically compensated. In addition, all couples and instruments

*Professor of metallurgy, University of Kentucky.

FIG. 1. ELECTRIC RESISTANCE-TYPE FURNACE, COVERS ROLLED BACK, LOOKING DOWN

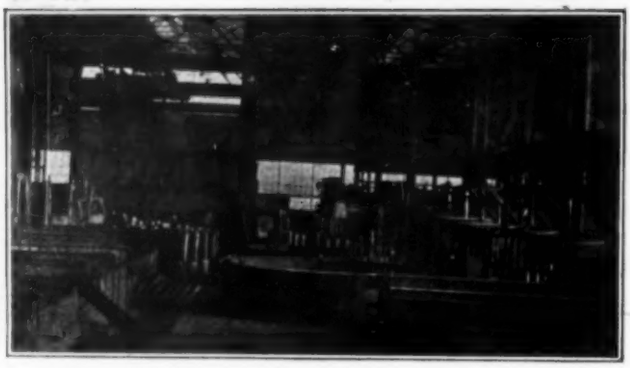

FIG. 3. FURNACE ROOM
Left, furnace pit; center, quenching tanks; right, cooling pit.

were carefully checked and standardized at frequent, stated intervals.

In addition to the furnaces, there were four cooling pits similar in design to the furnaces, but having no provision for heating. There were also two quenching tanks, one for water and the other for oil. However, after the first few weeks of treatment the oil, which was Robisoil No. 2, specific gravity 0.865, flash point 395, viscosity 140, was supplanted by water. In order to keep this cool, it was pumped out of the building, sprayed and returned to the tank. A general view of the whole department is given in Fig. 3.

Forgings to Be Treated

There were but two main classes of forgings treated, one of which will be called class A and the other class B, as shown in Fig. 4, the latter having the greater cross-sectional area, but being shorter. Both classes, however, varied in cross-section within themselves—that is, there was a certain cross-sectional area down to a shoulder and then a certain greater area below the shoulder.

Class A forgings were 9½ ft. long, the small section extending for 3 ft. 9 in. to a shoulder. The overall diameter at the small end was 6 in. and the diameter of the bore 2½ in., leaving a wall thickness of 1¾ in., while the overall diameter at the large end was 6⅝ in., with a bore diameter the same as the other end, leaving a wall thickness of 2⅛ in. The first 6 in. of the smaller end, which was the waste or test metal, was slightly larger than the balance, thus leaving a slight shoulder under which clamps were placed and the forging thus attached to the spider. The approximate weight of the forging was 780 lb.

Class B forgings were 4 ft. long, the small section extending for 2 ft. 8 in. to a shoulder. The overall dimension at the smaller end was 9 in. and the diameter of the bore 5¾ in., leaving a wall thickness of 1⅝ in. The larger end was quite irregular, but averaged about 11½ in for an outer diameter, while the bore diameter was 7 in., leaving a wall thickness of 2¼ in. This forging was suspended from rods thrust through holes bored in the 6 in. of test metal at the smaller end, as there was no shoulder at this end. The bore at the shoulder contracted to about 2½ in. in diameter for about ½ in. of length, making a heavy section at this point. The approximate weight of the forging was 407 lb.

Operations were started on 3 per cent nickel steel forgings (although a few contained some chromium as well as nickel), the carbon averaging around 0.38 per cent. The forgings were received direct from the forge plant with nothing done to them aside from a green anneal to relieve the forging strains. After receipt at the plant they were rough machined and bored, then heat treated and tested, then finish machined, bored and assembled.

Careless Original Practice

The initial heat-treating practice was to place the forgings in a furnace entirely disregarding its temperature and without making any attempts to segregate the forgings in a charge with respect to their carbon content. The temperature of the furnace at this time, prior to the introduction of the forgings, averaged around 1,225 deg. F. (660 deg. C.). The charge was then brought to a temperature which averaged 1,425 or 1,525 deg. F. (775 or 830 deg. C.), depending on whether the forgings were to be quenched in water or in oil, in a length of time that averaged 3½ hr., when it was quenched in either water or oil, the medium chosen depending on the uniformity or lack of uniformity of the cross-sectional area of the forging, the one of uniform cross-sectional area being quenched in water and the one of irregular cross-section in oil. The object of this was, of course, to avoid cooling one part faster than another and so prevent strains from being set up that might crack the forging.

The temperature of the water before quenching was between 80 and 90 deg. F. (30 deg. C.) and the time of immersion averaged around 2 min. The temperature of the oil was a variable depending on how frequently it was used, as there was no provision made for cooling it. The time of immersion varied somewhat with the temperature of the oil, but for the same temperature it was always several times the period of immersion when water was used.

After quenching, the forgings were immediately put back into a furnace for the draw, its temperature averaging around 1,000 deg. F. (540 deg. C.) before the forgings were placed in it. The charge was then raised to a heat of between 1,100 and 1,200 deg. F. (620 deg. C.) and held at that temperature for about 1½ hr., the time of raising to heat being about 2½ hr.

In all cases the time that it took to raise a charge to heat varied with conditions and the time of holding at heat was regulated by the necessity of having each forging heated entirely through at the particular temperature desired. Also the operator had to be sure that sufficient time was given for the necessary changes to take place in the steel after the critical range had been passed, these changes being somewhat slowed up by the presence of the nickel.

After the draw was complete the charge was removed to a cold pit and allowed to cool to below 600 deg. F. (315 deg. C.) with the pit covers closed. This was for the purpose of protecting the forgings from air currents which might cause unequal cooling, setting up strains in the steel and causing warping and cracking.

As previously stated, there was about 6 in. of waste metal left on each end of both classes of forgings for

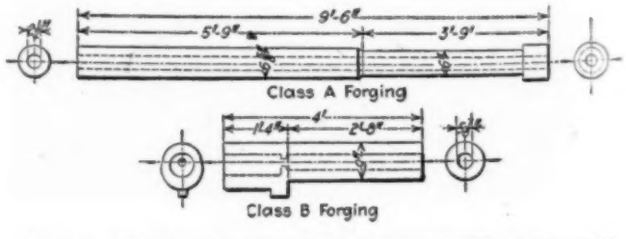

FIG. 4. SIZES OF NICKEL-STEEL FORGINGS TREATED

the purpose of furnishing test metal. After heat treatment, transverse bars were cut from this waste metal, one from each end, the bar from one end being diagonally opposite from the bar on the other. These bars were then shaped in shapers and turned down in lathes to the standard test bar 0.505 in. diameter, 2 in. between prick points. There were batteries of saws, drills, shapers and lathes kept for this purpose only. The bars were then pulled on one of three Riehle testing machines and the data carefully recorded and the fractured test pieces saved. The shapers, lathes and testing machines were run by girls under the supervision of men and, after a short period of training, they became very proficient.

After a considerable number of forgings had been tested, it was found that while some of them passed specifications there was no uniformity of result and something would have to be done to improve the percentage of acceptable pieces. The fractured test bars also showed a large number of flakes, of which I will say more later.

Segregation According to Composition

A careful study of the results indicated that each heat-treatment charge should be made up of forgings with similar carbon content, within limits, and the heat treatment, especially the drawing temperature, regulated accordingly.

This was then done and the treatment changed so that the quenching temperature averaged about the same as before, but with the drawing temperatures ranging as low as 970 deg. F. (520 deg. C.). The time of holding at heat in the draw was also lengthened to 6 hr., though subsequently it was found that while this long time did no harm neither did it apparently do any good, so for the sake of economy it was materially reduced.

This practice increased the percentage of passed forgings to some extent, as was expected, but flakes and streaks still continued to appear in the fractured test bars.

Description of Observed Flakes

Before going any further I will define "flake" and "streak" as they occurred in the transverse test bars. A flake is apparent to the eye as a spot of any size occurring in the fractured surface of the test specimen and extending transversely across it, the plane of the flake being parallel to the long axis of the forging. A streak is a bright band, generally about 0.02 in. (0.5 mm.) in width, apparently of the same nature as a flake,* but having the plane of the defect at right angles to the long axis of the forging. In other words, when testing transversely a "streak" is a flake parallel to the axis of the test piece, a "flake" is perpendicular to it.

Flakes Ascribed to Strains in Steel

A cause for the existence of these flakes and streaks was then sought, and it was generally agreed that they were due to strains in the steel, but whether they were in the steel before heat treatment, whether heat treatment caused them, or whether, if they were present before treatment, the treatment could eliminate them was not plain. Accordingly a careful study of the treatment was made to see if undue strains were being set up in the forgings by the practice being followed at that time, and it was decided that the habit of putting a cold forging in a hot furnace was very apt to set up strains in the steel and that even though these strains were not sufficient to cause flakes the practice was not a good one and should be eliminated. In this connection the following test was made. One end of a small metal rod, on the other end of which was a telephone receiver, was thrust through a thermocouple hole in the side of a furnace and up against a forging. By listening at the receiver a person could hear what seemed to be straining or cracking noises when the forging was heated rapidly and this apparently indicated a rather severe straining of the metal under the given conditions. However, this experiment could not be taken as conclusive, as the intensity of the sounds, and even the very existence of them at all, varied with the listener.

However, in view of the above findings, the experiment was tried of putting the forgings into a cold furnace and bringing them to heat very slowly, the time varying from 16 to 20 hr. and, at times, even longer. This practice was tried for about 10 days, but only as an experiment, being diametrically opposite to the previous practice of putting the forgings in a hot furnace and bringing them to heat as rapidly as possible. Ten days was found to be sufficient to get enough data on which to base conclusions.

Of course the extreme length of time involved in bringing the charge to heat precluded the adoption of this method commercially, but the results obtained showed that it was a step, though a radical one, in the right direction. However, flakes and streaks still persisted, and it was decided that they must be formed prior to forging, which the writer had contended right along, and experiments were accordingly undertaken with that idea as a basis.

Flakes Found in Ingots

As previously stated, the steel was made and forged at another plant than where treatment and machining were done. The casting practice at that time was to cast into square ingots and cool in the air. Experiments were begun at the beginning of things, therefore, and a number of these square ingots were cut open. It was found that flakes appeared along the diagonal lines across the ingot from corner to corner. As the corners or edges of a square ingot cool first, thus setting up strains along these same diagonal lines, it was deduced that flakes were caused, in part at least, by cooling strains and experimentation proceeded accordingly.

The shape of the ingots was changed from square to octagonal and the hot ingots were stripped and buried in ashes to cool, thus insuring very slow and uniform cooling. A number of these ingots were then cut open and flakes were found to have been practically eliminated. This casting and cooling practice was accordingly followed from then on, with such modifications as conditions from time to time indicated, and very little further trouble was experienced with flakes.

This all proved that while the initial heat-treatment practice was not all that it might have been, still the low percentage of passed forgings was due as much to poor steel as it was to poor heat treatment.

As stated before, the long time required to bring a forging to heat when put in a cold furnace and raised very slowly precluded the use of this practice commercially, so the following scheme was evolved which worked out very well.

It is generally agreed, I believe, that if the difference in temperature between the furnace and the forgings

is not more than 300 to 400 deg. F. (175 deg. C.) no undue strains will be set up in the steel and also that after the forgings are raised to a temperature of between 600 to 700 deg. F. (340 deg. C.) even a greater difference in temperature will do no harm. Working on these premises, one furnace was set aside for a preheating furnace, the cold charge being placed therein when the furnace temperature was around 400 deg. F. The charge was then brought up to about 700 deg. F., when it was removed to another furnace which was at a considerably higher temperature and there brought to heat. The temperature of this second furnace before receiving the charge varied from 1,000 to 1,200 deg. F. (600 deg. C.) depending on circumstances. As far as the draw was concerned, the forgings were removed from the quenching bath at a sufficiently high temperature so that they could be put into a furnace at a relatively high temperature without any harm ensuing.

The foregoing improvements in both steel and treating practice resulted in a material increase in forgings passed, but the percentage was not yet what it should have been and a study was made of the quenching and drawing temperatures to see what improvements could be inaugurated along those lines.

At this time 3 per cent and 2 per cent nickel-steel and 3 per cent nickel-chromium steels were being treated, and it was found that the quenching temperatures could

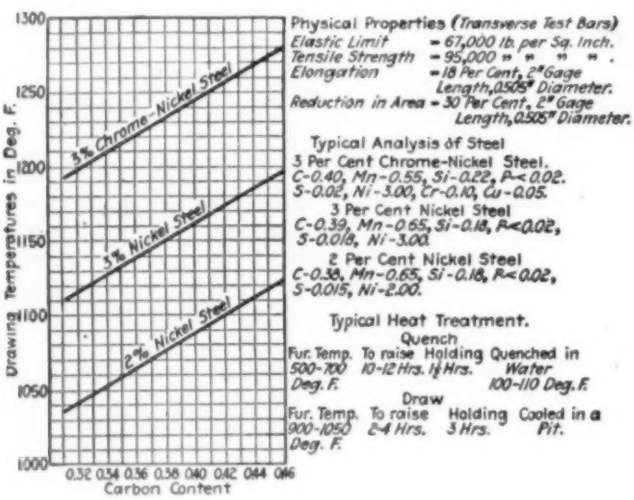
Drawing Temperatures in Deg. F.
1300
1250
1200
1150
1100
1050
1000
3% Chrome-Nickel Steel
3% Nickel Steel
2% Nickel Steel
0.32 0.34 0.36 0.38 0.40 0.42 0.44 0.46
Carbon Content
Physical Properties (Transverse Test Bars)
Elastic Limit = 67,000 lb. per Sq. Inch.
Tensile Strength = 95,000 " " " " .
Elongation = 18 Per Cent, 2" Gage Length, 0.505" Diameter.
Reduction in Area = 30 Per Cent, 2" Gage Length, 0.505" Diameter.
Typical Analysis of Steel
3 Per Cent Chrome-Nickel Steel.
C-0.40, Mn-0.55, Si-0.22, P<0.02. S-0.02, Ni-3.00, Cr-0.10, Cu-0.05.
3 Per Cent Nickel Steel
C-0.39, Mn-0.65, Si-0.18, P<0.02, S-0.018, Ni-3.00.
2 Per Cent Nickel Steel
C-0.38, Mn-0.65, Si-0.18, P<0.02, S-0.015, Ni-2.00.
Typical Heat Treatment.
Quench
Fur. Temp. 500-700 Deg. F. | To raise 10-12 Hrs. | Holding 1½ Hrs. | Quenched in Water 100-110 Deg. F.
Draw
Fur. Temp. 900-1050 Deg. F. | To raise 2-4 Hrs. | Holding 3 Hrs. | Cooled in a Pit.

FIG. 5. RELATION BETWEEN PHYSICAL PROPERTIES AND DRAWING TEMPERATURES IN THE HEAT TREATMENT OF LARGE NICKEL-STEEL FORGINGS

be practically standardized for all three classes if the drawing temperatures were properly adjusted. The following practice was accordingly evolved, which resulted in passing about 85 per cent of the forgings on the first treatment.

The forgings were placed in a furnace which was at a temperature of from 500 to 700 deg. F. (315 deg. C.), heated through to this temperature, and then transferred to another furnace which was at a higher temperature, as explained before. In this second furnace class A forgings were raised to a heat of 1,475 deg. F. (802 deg. C.) and class B forgings to 1,500 deg. F. (816 deg. C.) in a time of from 8 to 12 hr. They were then held at heat for a time of 1½ hr. for class A and 2 hr. for class B forgings and quenched in water.

For class A forgings the time of total immersion was 1¼ min., at the expiration of which time the forgings were pulled up till the shoulder was just beneath the surface of the water, when the heavy section was given an additional quench of 30 sec. In the case of class B forgings the time of immersion of the whole forging was 1 min., with an additional minute for the heavy section. These quenching times were found to be adequate for getting the proper quenching effect and yet did not cool the forgings so low as to cause cracks, which danger is always present in alloy steels. Neither did the forgings lose an unnecessary amount of heat, thus causing the necessity for more power consumption and a needlessly long time for bringing the charge to heat in the draw.

After the quench the charge was put back into the drawing furnace, whose temperature varied from 900 to 1,050 deg. F. (525 deg. C.) and raised to heat in from 2 to 4 hr. It was held at heat for 3 hr., removed to a closed pit and cooled to below 600 deg. F. (315 deg. C.) with the pit covers closed.

As stated before, the practice outlined above resulted in the passing of about 85 per cent of the forgings on the first treatment and was followed, with perhaps minor modifications for varying conditions, from the time it was evolved till the plant closed.

The accompanying chart, Fig. 5, shows the relation between the drawing temperatures and the carbon content of the steel for the three classes of material used, the forgings in all charges used in preparing the chart having passed test on the physical properties shown.

In conclusion the writer wishes to state that the above article was written before the recent rather general discussion in the technical press on flakes in nickel-steel forgings and he wishes to be understood as advancing no theories, but as merely stating facts, leaving the reader to draw his own inferences.

Lexington, Ky.

Conserving Canada's Pulp-Wood Resources

Canada produces something like 800,000 tons of paper per annum, and after supplying its own needs finds a ready market in the United States for the greater part of the remainder. The Dominion is making rapid progress with the development of its wood-pulp industry, the output of which, according to the latest available official figures, rose from 363,079 tons in 1908 to 1,464,308 tons in 1917.

Its illimitable virgin forest areas and its policy of conservation and reafforestation should in the near future make Canada one of the greatest pulp and paper producing countries in the world, but today it cannot meet anything like the demand for either commodity from the United States—which normally takes 75 per cent of Canada's output of paper—or from Great Britain, Australia, New Zealand, and South Africa. The provincial governments of Canada, in refusing to permit the export of pulp wood grown on Crown lands, are naturally unwilling to exploit their forests without regard to conservation, but are perfectly willing to continue to send to the United States most of their output of print paper.

It is extremely doubtful whether the paper consumer—large or small—will experience much relief in respect of prices within the next two or three years. While wood pulp continues to be the principal raw material for paper, conservation of the world's pulp wood areas should certainly be supplemented by a thorough investigation of the adaptability of other fibers to paper-making purposes.

The Chemical Engineer—His Functions and Training*

An English View of the Functions of Three Classes of Chemical Engineers: Those Employed in Chemical Works, Those Engaged in Manufacturing Chemical Plant, and Consultants—Suggested Curricula for Students Who Have Had Preliminary Training in Chemistry or Engineering

By J. H. WEST

MUCH has been written at various times on this subject, and it is one of peculiar importance just now in view of the great and increasing interest which is being taken in the provision of adequate facilities for the training of chemical engineers in this country [England]. It is, however, evident that there is still much confusion of thought as to the proper functions of a chemical engineer, and until this matter is cleared up there can be no real progress in devising the correct lines upon which his training should be carried out. The recent very interesting informal discussion on "What Is a Chemical Engineer?" at the Chemical Industry Club provided a further proof of this confusion of thought, some speakers even going so far as to consider a chemical engineer as a sort of super-plant-superintendent.

The object of this article is to analyze the functions of chemical engineers in relation to chemical manufacture, to classify these functions into their various groups, and then to discuss the various sources from which the chemical engineers of the future are likely to come, thereby arriving at the nature of the training they will have had previous to entering upon the study of chemical engineering proper, and finally to offer some suggestions as to the training they will require, and how this is to be provided. The writer does not desire in any sense to lay down the law on these matters, but rather to open the way for an unbiased consideration of this subject, which is of the highest importance to the whole British chemical industry, based upon clear thinking and a practical appreciation of the actual conditions under which chemical manufacture is being carried out to-day.

The report of the British mission which investigated the German chemical factories in the occupied territory makes it clear that Germany's past supremacy in the chemical industry was not due to superior and exclusive knowledge on the part of her chemists, but rather to highly organized and well-thought-out methods of manufacture carried out in scientifically designed plants. There is still, unfortunately, a certain amount of apathy among British chemical manufacturers regarding these questions, though not nearly as much as before the war, some of the older concerns attaching far more importance to guarding the secrets of their old-time methods than to keeping in touch with new methods and new discoveries. Others, however, realize even now that a bitter fight for commercial existence may soon be upon them, and they are making their plans accordingly. It is essentially the chemical manufacturer who is chiefly interested in obtaining and utilizing competent chemical engineers, and any criticisms or suggestions regarding the points referred to in this article will be most heartily welcomed from chemical manufacturers, and also from others who are interested in the training of chemical engineers.

Functions of the Chemical Engineer

Chemical engineers may be divided into three main classes. First, those who are employed in chemical works; second, those who are engaged in manufacturing chemical plant; and, lastly, consultants. These three classes will be dealt with in turn.

The Chemical Engineer in a Large Works

In order to arrive at a clear understanding of the functions of a chemical engineer engaged in a chemical works it is necessary first to consider his duties in a large works where the organization is highly developed with a large staff, and consequently there is less overlapping of duties than is inevitable in a small works with a correspondingly small staff, because such overlapping tends to obscure his true functions. These duties were fully gone into by the present writer in a previous article[1] and it is not, therefore, necessary to go all over the ground again, but there are certain points which must be emphasized, and in order to make them clear it is here necessary to make a digression.

Phases of Chemical Manufacture

The principal point, in the writer's opinion, is that there are, and must be, three distinct sides or aspects of chemical manufacture, leaving aside financial and selling considerations. These are the chemical side, the manufacturing or production side, and the engineering side. The second is by far the most important, for it is obviously the main business of the works, and the two others are merely adjuncts necessary in order that the production side can be carried on. It is becoming more and more realized by progressive manufacturers that production is a science in itself, which should be kept separate from other phases of the work and placed in the hands of trained production experts. In any manufacturing industry, whether gas-engines, boots, chemicals or anything else is being made, the production man is given certain materials to transform into certain products, and he is provided with the necessary means of doing this—viz., first, what may be termed plans of operation, for lack of a better term; second, plant; third, labor; fourth, energy; and lastly, subsidiary materials, other than raw materials.

Take the case of a works making gas-engines. The raw materials are pig iron, ingot metals for non-ferrous alloys, bar and sheet metals, and various sundries. The plans of operation consist of the designs for the gas engines prepared by the designing and drawing office staff, and the methods of manufacture which are worked out partly by the drawing office and

*Reprinted from the *Chemical Trade Journal and Chemical Engineer*, June 5, 1920, p. 727.

[1] "The Manufacturing Organization of Large Works," *Chem. Trade J.*, Feb. 9, 1918.

partly by the tool-room staff. The modern tendency is all toward working out the various processes of foundry work, machining and assembling beforehand by the joint drawing office and tool-room staffs, so that the production man gets all these matters cut and dried, and has not got to work them out for himself.

The case of chemical manufacture is almost exactly parallel. The raw materials depend upon the products to be made. The plans of operation are the chemical processes as worked out by the chemical staff, and the methods of carrying out the various chemical and physical operations as worked out by the chemical engineering staff. Here, again, the production man should be provided with all his requirements without having to bother himself about them, so that he can devote his whole time and energy to his own job, that of production. Now, production is not chemical work, and it is not engineering. It is a thing apart, calling for special knowledge of organization, the handling of labor and materials, the saving of time, and the economics of manufacture, as well as some knowledge of chemistry and engineering. There are many people who believe that a chemical plant can be run successfully only by a chemist. If that is true in the case of a given plant or process it is a sure sign that either the process has not been fully worked out by the research chemist, or that the plant and methods of operating have not been properly worked out by the chemical engineer. When a chemist says that he must run a process himself it simply means that he has turned over an incomplete process to the works and that he will complete his research on the plant itself. Now, a manufacturing plant is not the proper place for research if it can possibly be avoided, because research in such a plant inevitably means interference with production.

In the case of large firms with a well equipped semi-manufacturing scale laboratory practically every point regarding both process and plant can be worked out there, but smaller firms regard these laboratories as luxuries beyond their means, though in reality they would in most cases recoup the entire cost of such a laboratory within a year by the saving in time and money on their manufacturing plants. However, if there is no such laboratory the final stages of the process and plant research must be carried out in the manufacturing plant; but this should be placed under the control of the production man from the outset, with the chemist and chemical engineer to assist him until the initial difficulties have been overcome and the production is working smoothly. When this stage is reached the investigation of the process and plant and the methods of working should be so complete that the whole thing is practically foolproof. The production man should then, and then only, take full charge, leaving the chemist and the chemical engineer free to tackle other problems, and only needing to be recalled to give advice if and when other difficulties arise.

Production Work Not Real Chemical Work

Once the production is going smoothly by no stretch of the imagination can it be claimed that there is any real chemical work, in the highest sense of the words, involved in carrying it on. There will be routine testing of raw materials and reagents, and of the products at various stages of manufacture, including the finished article, but once these tests have been worked out and systematized a chemical student straight from college could carry them out, and how any chemist who is a real chemist can wish to have anything more to do with the plant when there is other research work—real chemical work—waiting to be done is a mystery, except that many chemists seem to prefer any sort of work almost to chemical work. There is no reason why a man who has been trained as a chemist should not take up production work in a chemical factory, provided he acquires the necessary knowledge of the science of production, and his chemical knowledge will be very useful to him; but he should frankly acknowledge when he does so that he has changed his vocation and is no longer doing the work of a chemist. The same thing applies to a chemical engineer who desires to run his plants when they are completed. Let him do so, if he has the necessary knowledge and ability, but let him also realize that by so doing he has ceased to work as a chemical engineer.

Duties of Chemical Engineer

True chemical engineering is a branch of engineering, just as much as electrical engineering or mining engineering, and it is nothing else. The real chemical engineer must be an engineer first, last and all the time, and his original training must be an engineering training, including the serving of an apprenticeship in the shops, as in the case of any other true engineer. To this must be added a real aptitude for and knowledge of chemistry, physics, and physical chemistry, particularly the two latter. It is primarily a man with such a training followed by sufficient practical experience who will be best fitted for carrying out the design and construction of original and complicated chemical plant without outside assistance. This work is the principal function of the chemical engineer, but he must be prepared, in addition, to assist and advise the various experts in other branches of engineering, such as power and steam engineers, structural engineers and electrical engineers, who will be on the staff of a large chemical works, or who may be called in from outside, regarding the special requirements of chemical works in these directions. He must, further, in order to fulfill these functions, collaborate closely with the chemical staff, the production staff, and the other engineering experts, including the repairs engineer, and he will have to deal with outside makers of plant, and select the most suitable types, arranging for any modifications of the makers' standards, if such be absolutely necessary.

Putting a Process on a Commercial Scale

The ideal method for preparing a laboratory chemical process for conversion into a manufacturing proposition would be a joint investigation carried out in the closest collaboration by the chemist, the production man and the chemical engineer, bearing in mind that the production man, as representing the commercial point of view, is the most important. The chemist would therefore have to satisfy him that the process he submitted involved no waste of materials by the use of excess reagents beyond that absolutely necessary to carry out the reactions, that expensive reagents were not to be used where cheaper ones would do, that the yields had been pushed to the highest point attainable, and that the use of power and heat had been reduced to a minimum. The chemical engineer would have to satisfy him that the plant proposed was in every way suitable and efficient, and that economy of labor, power, heat, cooling water, etc., had been fully provided for. By the production man is here meant the head man or production superintendent of the whole works. The man who

is to run the plant should be brought into touch with it during the construction period, so that he will be familiar with every detail of the plant and process before he has to begin operations. A board of directors who insisted upon the preparations for manufacturing their products being carried out in this way would feel confident that not only were they using their staff to the best advantage but were insuring commercial success as far as that can possibly be done.

The Chemical Engineer in a Small Works

So much for the works chemical engineer in a large works where his duties are highly specialized, and therefore clearly defined. We come next to the smaller works, where there is a chief chemist, with one or two research and routine chemists under him, and a chemical engineer. Here again, in the writer's considered opinion, far-seeing manufacturers who study organization and think out things for themselves will ultimately be driven to the conclusion that it is better to employ special production men to run the plants, and use the chemists and engineer to do their own proper work. In this case the methods of collaboration by chemist, production man and chemical engineer will be similar to those already considered, but if shift chemists are to run the plants the chief chemist alone will collaborate with the chemical engineer, and the onus of securing maximum economy of labor, power, heat, etc., will lie upon the latter. In either case the whole of the engineering work will have to be carried out by the chemical engineer, unless outside experts are called in, say, for instance, where a whole new works has to be laid out. It must be realized that the engineering problems connected with a chemical works cover such an enormously wide field that it is absolutely impossible for any one man to have expert knowledge of every phase, but, as before explained, the chemical engineer will assist these experts in satisfying the peculiar requirements of the chemical works.

Where the Chemist Is Also the Chemical Engineer

Lastly we come to the all too common case of the works where there is a trained chemist but no chemical engineer, his place being taken by an engineering foreman as a rule, very often an ex-sea-going engineer who has picked up a practical knowledge of chemical plant, but has no knowledge of the principles of chemical engineering. This is a state of affairs which will probably cease to exist in a few years, when there is an adequate supply of trained chemical engineers, but it is very common at present, and it has led to the idea that if the chemist in such a case studies chemical engineering he can combine his own functions with those of the chemical engineer, thus becoming a sort of hybrid. That this is the sole conception of a chemical engineer possessed by many people was evident from the remarks of several speakers at the Chemical Industry Club debate, before alluded to. In fact, it was suggested that the name for this hybrid was badly chosen, and that it ought to be engineer-chemist. There is truth in this suggestion, for how can a man without a proper engineering training be an engineer? That a knowledge of chemical engineering, even of the most empirical kind, is most valuable to such a man is obvious, and that with the aid of outside engineers or chemical plant-makers he can do farily good work in getting together plants in which to carry out his processes is not denied. There must be hundreds of chemical works in operation today which have had every bit of plant in them got out and put up on these lines, but such a man is not a chemical engineer, or an engineer at all in the true sense.

Research Should Precede Large-Scale Production

It is most probable that here we come up against the fundamental difference between British and German methods. The British manufacturer is satisfied if his staff can get together and put up a plant which will turn out a given product, and as soon as the process has been decided upon the plant is got on with and production is begun, all question of commercial efficiency and most of the snags and difficulties of large-scale manufacture being left over until the plant is working. It is not too much to say that many chemical plants in this country remain in the experimental stage for several years after they start producing, and some plants seem never to emerge from this stage at all. The result is variable quantity and quality of output, with correspondingly disappointing financial returns, due to the occurrence of difficulties which ought to have been investigated and got over beforehand. The German manufacturer, on the other hand, insists upon every phase of both process and plant being worked out in advance by highly trained specialists. In other words, the research work is carried much further than is done here, where research is usually restricted to the purely chemical laboratory-scale stage, instead of being carried right up to the manufacturing stage, both as regards process and plant. Research on the chemical engineering and production sides is just as necessary as on the chemical side.

A well-equipped semi-manufacturing-scale laboratory is exceedingly useful for this work, but much can be done with odd pieces of spare or disused plant, and the proper use of the quantitative flow sheet, on which the history of every pound of raw materials, reagents and solvents, and every unit of heat and other forms of energy, from the moment they enter the plant to the moment they leave it, is worked out as closely as possible, will throw a flood of light on the extent and exactness of the knowledge of the process and the plant which has been acquired. With regard to the hybrid engineer-chemist, while it is admitted that he can devise, put up and run plants, can he possibly have sufficient specialized knowledge of the chemical, the engineering and the production sides to do full justice to all three? Heaven knows life is all too short for acquiring adequate knowledge and experience of one small corner of one branch of one department of technology, without attempting more than one.

The Chemical Engineer as Maker of Chemical Plant

Passing next to the second class of chemical engineers, those employed by firms manufacturing chemical plant, the functions and qualifications will be very similar to those of the chemical engineer in a large chemical works. A less extended knowledge of chemical plant will be demanded, because he will only be required to deal with the special types of plant manufactured by his firm, but, on the other hand, he will have to study the application of these types to a much wider range of chemical manufactures than the works chemical engineer, who is confined to dealing with only one class of chemical products. This class of chemical engineer, again, must be a properly trained engineer, capable of

designing plant not only suitable for the purpose intended but capable of being manufactured on economical lines at competitive prices. Makers of chemical plant can be, and are, of immense assistance to chemical manufacturers, particularly those who have no chemical engineer of their own, and there are plenty of honest makers who are willing to give disinterested advice whether it results in the sale of their own plant or not. There are, unfortunately, others, happily in the minority, who are sufficiently blind to their own real interests to push the sale of their goods, irrespective of the suitability or otherwise of these for the purpose in view.

The Consulting Chemical Engineer

Finally, we have the consulting chemical engineer, who may have started life as a works chemical engineer or as a maker of chemical plant, and, provided he has had a thorough training and a sufficiently wide experience, it does not matter which. The proper functions of a consulting chemical engineer are to advise on the design and construction of chemical plant, the layout of chemical works, and, either alone, or in the case of large and important undertakings preferably in consultation with other experts, upon the other phases of chemical works engineering, such as buildings and the supply of steam and power. It is no part of his business to advise upon the purely chemical side of processes, any more than it is the legitimate business of consulting chemists to advise upon the design of chemical plant, yet consulting chemists frequently do the latter, sometimes with disastrous results, and consulting chemical engineers are often expected to do the former. Here again, in this age of specialization, overlapping of functions is greatly to be deprecated. In the consulting chemical engineer the chemical manufacturer who has no chemical engineer of his own can find an unbiased arbitrator between himself and the maker of chemical plant.

Training the Chemical Engineer

In considering the training of the chemical engineer it is necessary to differentiate carefully between the various classes of men who require training. Starting with the college student, it must be pointed out that at present, anyway, chemical engineering must be considered as more or less a post-graduate subject or as a subject to be taken up after the student has put in at least two years on either engineering or chemistry. consequently the training required will be very different in its early stages, according to the previous record of the student. The supply of students who begin with an engineering training, and later on take up chemical engineering, is likely to be small for some years, or until chemical engineering comes to be recognized as a well-defined and attractive branch of engineering, but it is probably men of this class, engineers at heart, with an aptitude for chemistry, who will make the best chemical engineers of the highest type. These men will have served their time in the shops, either before going to college or during their engineering course on the so-called sandwich system, and they will have had a thorough grounding in engineering subjects, so that they need not devote time to these subjects during their first year at chemical engineering. They should rather study as much chemical technology, physical chemistry, electrochemistry and thermodynamics as possible, plenty of laboratory work in all these subjects being included, and one day per week being devoted to the principles of chemical engineering.

On the other hand, students with a chemical training should in their first year give three days a week to engineering subjects, including applied mechanics, strength of materials, machine drawing and design, and building construction, with one day on thermodynamics, physical chemistry and chemical technology, and the remaining day on chemical engineering principles. During the second year all students would devote most of the time to the principles of chemical engineering and the design of chemical plant, the remainder of the time being spent on chemical and physical subjects by the engineering students, and on engineering and physical subjects by the chemical students. The economics of chemical manufacture should also be dealt with, and such matters as the factory law relating to chemical works, safety appliances and the handling of labor. Students who can stay on for a third year would have advanced lectures on chemical engineering principles and practice, and would be encouraged to specialize in some branch of the subject in which they would carry out original investigations. The above is merely intended as a suggested general allocation of time.

Plant Experience Essential

Works experience is most essential for all students, and is very difficult to provide for. If it can possibly be managed students should spend some months in a chemical works, or failing that in the works of a firm making a wide range of chemical plant. Possibly one summer vacation spent in each kind of works would be the best arrangement. It is greatly to be hoped that chemical manufacturers, when they begin to realize that properly trained chemical engineers will be not only valuable but essential to them, will come forward to aid the educational authorities by opening their works to students during the vacations. Chemical students who wish to acquire some knowledge of chemical engineering—and this subject is bound to be of great value to every chemist who intends to enter the chemical industry, whether on the research side or the plant side, —would take as much of the above course as they could spare time for.

Chemical Industry Seeks Highly Trained Men

In this connection it is worth referring to some remarks made by Dr. E. F. Armstrong, F.R.S., at the annual dinner of the Chemical Engineering Group, to the effect that the supply of partly trained chemists was likely greatly to exceed the demand, and that manufacturers now wanted not merely pass or honors degree men but highly trained chemists capable of undertaking the highest type of research work. Such men will certainly require a knowledge of chemical engineering. It might be added that there will no doubt be good openings for men with a chemical training who definitely propose to go in for plant or production work instead of research work, and prepare themselves for this by studying the economics of chemical manufacture, the principles of plant and works management, and chemical engineering; if necessary, abbreviating their purely chemical training in order to do this.

The training of production men lies outside the scope of this article, but it would appear that there is great need for a systematic course of training for plant superintendents and works managers, arranged on broad lines suitable to any manufacturing industry.

The Copper Industry in 1919

THE principal features of the American copper industry during the year 1919 are shown in an advance statement on the production of copper in the United States by H. A. C. Jenison, of the United States Geological Survey, Department of the Interior.

The smelter output in 1919 was about 1,310,972,000 lb., a decrease of 597,561,000 lb. from that of 1918. The production of refined primary and secondary copper from domestic and foreign ore and metal was 1,863,580,000 lb., which was 612,497,000 lb. less than the production in 1918. Refined primary copper amounting to 326,043,000 lb. was produced from ore or other material imported from foreign countries, principally Chile, Peru, Mexico and Canada.

The discrepancy between the smelter production and the refinery production is due to the fact that 562,000,000 lb. of blister copper and other material was in process of refining at smelters and refineries or in transit on Jan. 1, 1919, and though it was smelted in 1918 it was not refined until 1919.

Exports Show Great Falling Off

In 1919 the imports of copper in all forms amounted to 429,388,000 lb., and the exports of copper in all forms amounted to 516,628,000 lb., which was 231,062,000 lb. less than the exports in 1918 and 616,205,000 lb. less than those in 1917. The exports in 1919 were less than in any year since 1907.

On Jan. 1, 1919, the stocks of refined copper were 180,000,000 lb., and on Jan. 1, 1920, they were 631,000,000 lb., an increase during 1919 of about 451,000,000 lb. The stocks on Jan. 1, 1920, were several times greater than they have ever been before.

In addition to the stocks of refined copper in hand about 310,000,000 lb. of blister copper and material was in process of refining at smelters and refineries or in transit on Jan. 1, 1920. This estimate does not include blister in foreign smelters destined for the United States for refining nor material in transit to the United States from such smelters.

The apparent domestic consumption in 1919 was about 876,564,000 lb., which is 785,106,000 lb. less than that in 1918 and less than the domestic consumption in any year since 1914.

Causes of Decrease in Output

Many causes contributed to decrease the smelter and refinery production, the domestic consumption, and the exports, and to increase the stocks, but the principal cause was a poor market. The industry was working at maximum capacity when the war demand for copper ceased, and it was then, of course, forced to continue production only at the rate required to supply the ordinary commercial and industrial demand. The war demand was stopped so suddenly as to disturb greatly the trade and industrial conditions, and the prospects for the immediate future appeared so uncertain that few industries were able to continue production without first decreasing it greatly and reorganizing, to some extent, their industrial mechanism.

Prices and Costs

Under the peace-time conditions the demand for copper was small and the average price soon fell from 24.7c. to about 15c. a lb. This price was far below the actual cost of the production of a very large part of the previous year's output. All smelters and mines were forced to decrease production. Some were shut down entirely; others were operated at the minimum capacity that would keep the organization intact and the equipment in proper order. Much of the copper in stock could not be profitably held, and the placing of a large part of it on the market kept the price down, though it showed a tendency to rise when the readjustment set in.

Price Lowest Since 1915

The price during the year showed many fluctuations but averaged only 18.6c. a lb., which was about 24 per cent less than the average price in any year since 1915, though the cost of labor and supplies had risen as much as 150 per cent during that time.

The labor troubles in other industries decreased the demand for copper, increased the cost of supplies used by the copper industry, and materially increased the cost of production.

Decrease in Foreign Demand

By the time the price of copper had risen high enough to permit the industry to meet these unfortunate conditions foreign exchange began to fall so rapidly that foreign buyers were unable or reluctant to purchase American copper, and finally the exchange between the United States and foreign centers dropped so low that they could no longer buy it. These conditions almost ruined the foreign market for American copper, and the demand and the price in the domestic market were less than they had been at any time for several years. On the whole, the year was an unsuccessful one, and in view of the conditions it is remarkable that the industry remained as stable as it did.

Prospects for 1920

It is hard to foresee what improvement can be expected in 1920, but the quantity of copper sold in the early part of 1920 indicates that the year will be better than 1919. Any improvement, however, will be temporary and no stability or security can be found until existing troubles are settled and industry and trade become more stable. The prosperity of the copper industry is peculiarly dependent upon the establishment of stability in other industries, and before the industry can receive any great stimulus the condition of labor and of trade generally, not only in America but in Europe, must be greatly improved. When that time comes the industry will undoubtedly be as prosperous as ever.

Manganese Addition Increases Life of Thermit Welded Wabblers

Successful results obtained from a considerable number of welds made by several large steel mills have shown, according to a statement by the Metal & Thermit Corporation, New York City, that the life of wabblers on pinions, rolls and large shafts which have been repaired by thermit welding, after previously having been worn away or broken, can be prolonged materially by the addition of 3 per cent pure manganese to the railroad thermit in addition to the 1 per cent pure manganese already in the thermit. This will give a hard wearing surface. Wabblers should be thoroughly heated to about 1,400 deg. F. before welding; otherwise no alloying of the two metals will be obtained.

Turpentine From British Columbia Firs

IN A recent interview E. S. Oliver, an industrial chemist and specialist on wood products, who has made a study of methods of extracting the maximum amount of resin from trees without injury to the growing tree, gave some interesting and valuable information in connection with the turpentine industry, which is attracting considerable attention among persons identified with the development of the resources of British Columbia. Mr. Oliver, who has in the past conducted investigations in Mexico and Central America and in the forests of Russia, Sweden, Germany and the Mediterranean countries, states that the greatest potential source of turpentine and resin chemicals lies in British Columbia.

Government Issues "Resin Leases"

At the last session of the provincial legislature of British Columbia there was passed an amendment to the Forest Act, whereby the provincial government is authorized to issue "resin leases" and to collect a royalty of three-quarters of a cent a gallon on all resin gathered, in addition to the fees and rentals paid into the Forest Protection Fund. The amendment was passed only after demonstrations by, and reports from, forestry officials showing that tapping for resin does not injure the growing trees.

The Oliver Method of Collection

Some of the interesting history of this new industry was revealed when Mr. Oliver pointed out that the very first ship which came from England to the shores of America bore instructions, written in the hand of Queen Elizabeth herself, as to the method to be employed in securing tree resin. "And," he added, "curiously enough, on this continent the very same methods are still followed. It is an industry which has shown no improvement in its methods of collecting its raw material."

Under the old system of scarifying the barks of the trees and collecting the resin after the more volatile elements had become oxidized by contact with the air, it was not possible to secure more than 17½ per cent bulk of turpentine. In Canada the highest production in any of the eastern plants was 15½ per cent. Under Mr. Oliver's tests the lowest he has received was 33 per cent, or 1 per cent higher than in Germany, where the resin byproduct industry has been developed to an art.

Process Benefits the Trees

Without disclosing any of the secrets of the process, it may be said that Mr. Oliver achieves his results by boring a very small hole into the tree trunk and hermetically sealing it to an air-tight flask. In this way, instead of injury being done to the timber, the growth of the tree is aided. The resin being in the nature of fecal matter which the tree is seeking to rid itself of, the quality of the timber and the rapidity of its growth are aided, the small drain holes not affecting the efforts of the tree to send up sap and build up new cells.

Many Valuable Resin Products

The theory worked out by Mr. Oliver to explain why larches and pines send out resin is that the pines and conifers are the survivors of a cold epoch which swept over the northern hemisphere. The only way in which the germ of life in the tree cell could endure was by the tree evolving a non-freezable and non-swelling substance to enwrap and protect the cells. Such a substance is turpentine, which forms a large element in tree resin. "With a return of warmth," says Mr. Oliver, "these trees now find themselves with a supply of resin for which they no longer have any use. The tree is always seeking to rid itself of the substance by discharging through the roots into the ground and by forming abscesses in the tree trunk. When the tree trunk is scarified or the bark injured the resin oozes out."

Among the valuable products obtained as a result of experiments with British Columbia Douglas fir resins are turpentine, fir oils which form the base of "fruit" extracts used at soda fountains, medical oils, etc., and resins which make varnishes of the highest grade. Printing inks are also made from the resin. One of the most interesting is Burgundy pitch, which, instead of being "pitch" black, is snowy white. Its greatest value is as a white ink for use in lithographic work.

Industry a Constructive One

"The greatest satisfaction," says Mr. Oliver, "is that the industry will be a constructive one, instead of a destructive one as practiced in the southern pine forests of the United States. Every tree, no matter how small or how ill shapen, so long as it is healthy can be made revenue producing. It will help the lumber industry and will itself become the greatest single industry in the province."

A Company Already at Work on Cortez Island

A local concern has started operations in Cortez Island, at the mouth of the Campbell River, about sixty miles from Vancouver, where twenty men are employed. The men now engaged in this work are mostly ranchers residing in that locality, but it is the intention of the Vancouver company to put on about 200 workmen. The method of pursuing operations is to secure sap rights from private owners. It is estimated that a block of about 100 acres of Douglas fir gives about 800 bbl. of pitch per year, or a total of about 40,000 gal. The rancher is also provided with employment if he so desires, at $5 a day. The majority of the landowners in the Cortez Island and adjacent districts are holding their property for the ultimate timber wealth, but the establishment of this new industry is adding much to the value of the forests.

Forty Gallons at a Tapping

The company is working on trees not less than 10 in. in diameter. Some of the larger trees are said to yield upward of 40 gal. at the first tapping. The pitch comes forth in colors varying from a bright green and deep red to a milky white. The color denotes the quality of the product, the bright green being of the highest grade. One gallon of sap produces about one-third gallon of high-grade "turps," while the residue is rich in valuable byproducts.

Forestry experts declare the Douglas fir to be the most valuable tree in the world for commercial purposes, not even excepting the rubber tree. The market is also extensive, while the price obtainable for turpentine and other resin products is four times that of prewar days.

Nitrate Industry in Chile*

A Succinct Review of the Operation of a Nitrate Plant for the Recovery of Sodium Nitrate, Iodine and Potassium Nitrate—Needs of Improvements in This Industry and Some of the Technical Problems to Be Solved

BY ALEJANDRO BERTRAND

THE topography of the Chilean nitrate fields permits the installation of plants so that a great part of the handling of the nitrate material can be carried out by using gravity as motive force. A typical arrangement of a nitrate plant is shown in Fig. 1. The essential parts are:

1. Receiving hopper (buron).
2. Crushers (acendraderas).
3. Lixiviation tanks (cachucos).
4. Clarification tanks (chuladores).
5. Crystallization tanks (bateas).
6. Nitrate drier (cancha).

The accessories are:

7. Means of transporting the material from one stage of operation to the following.
8. High and low pressure steam generators.
9. Evaporators to concentrate the nitrate liquor and eliminate the sodium chloride.
10. Power generators.
11. Steam and liquor pipings.
12. Reservoirs for water.
13. Apparatus for the separate treatment of pulverized material or of the washed residue.
14. Machine shop.
15. Iodine house.
16. Installation for the separation of potassium nitrate.
17. Installations for getting and purifying the water needed during all the operations of the plant.

CRUSHING

The run of mine has to be transported to the plant from some distance—sometimes up to 30 km. (about 19 miles). The material is dumped directly from the cars into a receiving hopper located at the highest level of the plant. From here the material reaches the crushers, where it is reduced to 4 to 10 cm. size (1.4 to 4 in.) plus a varying amount of pulverized caliche, according to the hardness of the raw material.

Very few plants use any screening between the hoppers and crushers for a preliminary separation of the fines and of the part already of the desired size. In newly installed plants there is a tendency to use screens placed before and after the crushing operation, thus improving the hygienic conditions for the workmen and rendering more efficient the subsequent treatment of the classified material.

LIXIVIATION

The usual lixiviation tanks are open and rectangular, made of heavy sheet iron, the dimensions being 2 m. wide x 2.5 m. deep x 7 to 10 m. long (6.5 x 8 x 23 to 33 ft.) with a maximum capacity of eighty tons of material.

Each tank contains a perforated false bottom placed at 20 cm. level (about 8 in.). Low-pressure steam circulating in pipe coils serves for heating. The tanks are interconnected with siphons and provided with outlets for the liquid and means for dumping out the residues.

A 100,000-ton-per-year plant needs on the average fifty such tanks, which occupy a floor space of at least 2,000 sq.m. (21,500 sq.ft.).

The washing progresses on the counter-current principle. Generally the unscreened material from the crusher is dumped into the tanks; but in the more modern installations, when screening is used, the fines are treated separately or placed on top of the coarser materials. The complete washing of one batch of material (fondata) usually requires from 12 to 24 hr. The maximum saturation temperature of the liquid is 121 deg. C. The final washing is done with cold liquor to enable the workmen to handle the residue as soon as the liquor has been drained off.

The end of the lixiviation is usually still determined by the guesswork of the foreman. The only data which might logically indicate the actual saturation point of the wash liquor could be obtained only by chemical analysis; but the local conditions are such that analyses vary from batch to batch and therefore are of little value in actual practice. It is therefore of common occurrence to have either an incomplete washing with loss of nitrate in the residue or an excess of washing with additional heat consumption. The residue is sometimes re-treated, but usually it goes to the waste pile.

CLARIFICATION AND DECANTATION

The clarification tanks are of sheet iron, rectangular, 4 to 5 m. long x 2 to 3 m. wide x 1 to 2 m. deep (13 to 16.5 x 6.5 to 10 x 3.3 to 6.5 ft.). The bottom is inclined, the slope being 4 to 5 per cent lengthwise. The capacity of the tanks is usually sufficient to receive the saturated liquor resulting from previous 24-hr. operation.

The settling time for the liquor depends on the amount of insolubles in suspension, on the nature of these insolubles and on the temperature. All these factors vary from batch to batch, with the result that the clarification time may vary between ten minutes and many hours.

An important efficiency factor is to maintain the temperature as nearly constant as possible and at a degree which corresponds exactly to that required for the realization of a nitrate-saturated liquor. Many reagents are used to accelerate the settling of the insolubles, especially of the colloids. Among the more commonly used are: ammoniacal water, sodium carbonate, lime water, guano, manure, flour, animal glue. The action of these reagents is not yet explained in a satisfactory manner.

A symptom which is generally taken as indicating the end of the clarification period is the formation on the

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surface of a thin layer of crystals of nitrate. As soon as this takes place the liquor is decanted into the crystallization tanks.

Crystallization

The crystallization tanks are of heavy sheet iron 4 to 6 m. x 3.5 to 4.5 m. and about 1 m. deep (13 to 19.5 x 11.5 to 14.5 x 3.3 ft.). The bottom is inclined, the slope being 2 to 4 per cent crosswise, and is provided with two to four outlets. The total capacity of the crystallization tanks is sometimes three times but usually about twice that of the lixiviation tanks; but, due to the poorer quality of the caliche now to be treated, the tendency is to equalize the capacities of the lixiviation and crystallization tanks. The liquor is kept in the crystallization tanks for five to eight days at atmospheric temperature. Theoretically the liquor ought to contain at the maximum 400 g. nitrate per liter of solvent (at the average night temperature of 10 deg. C.) and there should be no precipitation of sodium chloride, but due to the great amount of evaporation which takes place (3 to 4 per cent of the volume) there results a concentration which sometimes passes the sodium chloride saturation limit.

There are plants where the crystallization tanks are made up to 3 m. deep where the cooling take place with a smaller loss in evaporation, thus giving purer nitrates. The evaporation of the mother liquor ought to start only when there is no more precipitation of nitrate.

The nitrate crystals are separated from the walls and bottom and placed on inclined drain boards (falcas), whence the drained crystals are transported to be dried and packed for shipment.

During this operation care is taken to obtain only the deposition of nitrate, but this is seldom achieved, and the product is more or less contaminated with sodium chloride. This salt is separated by "refining," which consists simply of sprinkling the nitrate with fresh water or with water saturated only with nitrate. The water dissolves the chloride and is returned to the evaporating tanks and the refined nitrate is dried and packed for shipment.

Separate Treatment of Pulverized Material

It has been mentioned above that in some plants the crushed material is screened before it is charged into the lixiviation tanks and that the powdered material is placed on top of the coarser material in the tanks or is treated separately. This last treatment is still in the experimental stage.

The pulverized material is made up into a more or less loose mud and the insolubles are separated by mechanical thickeners, by filtration, by centrifuging, or by a combination of these agencies.

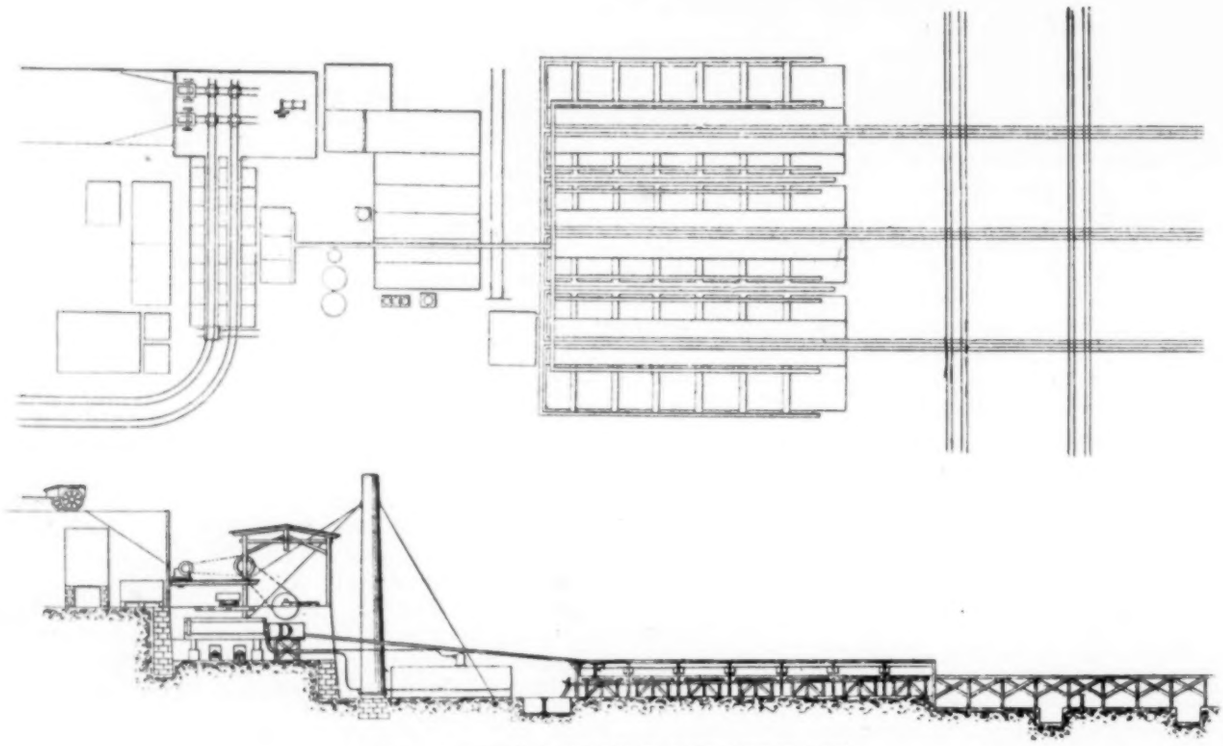


FIG. 1. TYPICAL CHILEAN NITRATE PLANT

The thickeners are of American make. The solids suspended in the liquid are submitted merely to a wet classification in cylindrical tanks with conical bottoms. The clarified liquid is decanted at the top and the thickened mud is evacuated at the bottom. This mud is generally passed through rotary filters and submitted to alternate suction and pressure. The rotation of the filter is slow (about one revolution per seven minutes with the Oliver type).

When no preliminary mechanical thickening is employed the filters used are of the "Butters" system. They consist of big leaves composed of a double layer of filter cloth which are immersed in the mud which is to be treated. The mud is heated somewhat and the space between the filter cloth layers is submitted to alternate vacuum and pressure. The results obtained with these filters are very encouraging.

Another method of treatment of the mud consists in the use of the "Burt" filter, which is a cylinder about 12 m. long (40 ft.) with an interior cylinder of filter cloth. The material to be treated is introduced in the inner cylinder and submitted to a pressure of 4 kg. per

sq.cm. and the cylinder is rotated at a speed of five revolutions per minute. The combination of pressure and centrifugal force accelerates the filtration. To clean the filter the pressure is applied to the outer side of the filter cloth, the rotation is increased, and the cake which is thus detached from the cloth is evacuated by the use of an Archimedean screw.

Of these methods the only one which gives highly encouraging results is the Butters method, first introduced in 1913. By its use it has been possible to increase the efficiency of a 15 per cent caliche from 7.5 to 10 per cent and to lower the operating cost about 20 per cent.

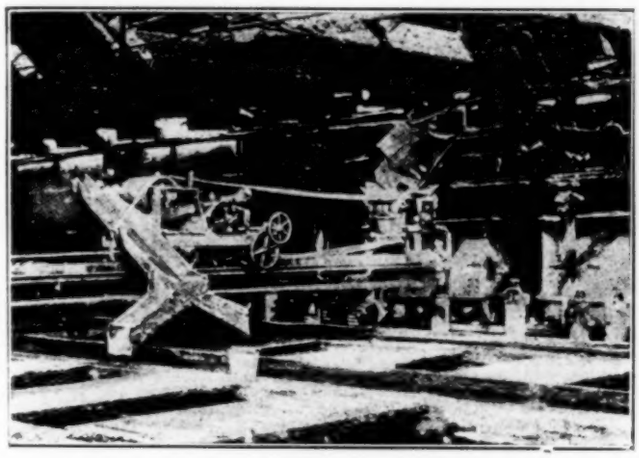


FIG. 2. WASHING, MECHANICAL DISTRIBUTION OF THE CALICHE

Production of Iodine

The caliche contains from 200 g. to 2 kg. iodine per ton in the form of a soluble salt, which during the cycle of operations outlined above is concentrated in the final mother liquor to about 8 g. per liter; but a part of the original iodine in amounts up to 250 g. per ton is found in the commercial nitrate as sodium iodate. Although the annual total amount of iodine in the caliche treated is over 5,000 tons, the actual annual iodine production before the war reached only about 500 tons, and the maximum ever produced was 1,000 tons, in 1916.

The process now used for the subtraction of the iodine is by treating the solution of sodium iodate with sulphurous acid, with the formation of soluble sodium sulphate and a precipitation of iodine. Care must be taken not have an excess of the reagent. In practice, instead of the sulphurous acid gas, sodium bisulphite is used. Here also an excess of reagent is to be avoided, otherwise soluble iodic acid is formed and lost. The bisulphite is prepared at the plant from sodium carbonate, nitrate, carbon and sulphurous acid. The last is obtained by burning the sulphur which is found in the nitrate district.

The precipitation of iodine takes place in wooden or tin sheet tanks. An excess of reagent with the resulting loss of iodine is easily discernible by a violet color of the mother liquor.

The operations subsequent to precipitation are filtration, compression and sublimation.

Potassium Nitrate

All the caliches—without exception—contain potassium nitrate from traces up to 4 per cent and some contain even as high as 10 per cent. A reasonable average would be 1 per cent.

The separation of the potassium nitrate from the sodium nitrate is accomplished by fractional crystallization. The saturation curves of these two salts cross each other at 66 deg. C. Above this temperature the potassium salt is the more soluble, but below this temperature the solubility of the potassium salt diminishes; thus at 20 deg. C. it is only a third, at zero deg. C. a sixth and at —15 deg. C. a twentieth of the solubility of that of the sodium salt. In some plants part of the potassium nitrate, amounting to 20-25 per cent of the total output, is crystallized out at the average atmospheric temperature. By a subsequent cooling to —15 deg. C. the separation of the potassium nitrate is quite complete, leaving in the final sodium nitrate only 5.5 per cent of the original total potassium salt contents.

Accessory Installations

Some of the nitrate plants are thoroughly modern in every way and the plants of the American du Pont de Nemours Co. and of the Chilean Antofagasta Co. have introduced the most modern improvements and constitute chemical plants which might well compare with the most up-to-date chemical works to be found anywhere. The same might be said about the organization and the welfare of the employees and their families.

Technical Progress in the Chilean Nitrate Industry

No substantial change in the method of working has been introduced during the last forty years, although a great many efforts are being made to find efficient improvements. More than 300 patents related to the Chilean nitrate industry have been taken out in Chile on about 500 new processes and on modifications in the old ones. About 34 per cent of all these patents deal with the stage of lixiviation, some proposing to activate lixiviation by mechanical methods (rotation, agitation, etc). Others propose preliminary classification of the raw material, to dispense with heating, to render the operation continuous, to operate in closed tanks under pressure or under a partial vacuum, to install the lixivia-

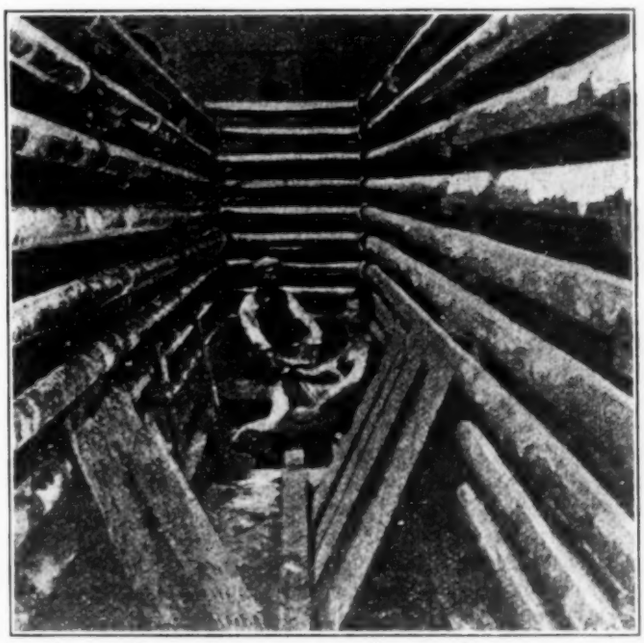


FIG. 3. INTERIOR OF AN EMPTY TANK

tion plants near the mines and instead of transporting the run of mine to the plant to pipe the saturated liquor to the plant, which might thus be located near the export harbors, etc. About 27 per cent of the patents refer to the different phases of the recuperation of the nitrate by evaporation and crystallization; about 10 per cent deal with a better use of the heat, and about the same amount of patents propose special methods for the treatment of pulverized caliche and of the residue. The remaining 19 per cent of the patents refer to the recovery of byproducts, such as iodine, potassium nitrate, etc.

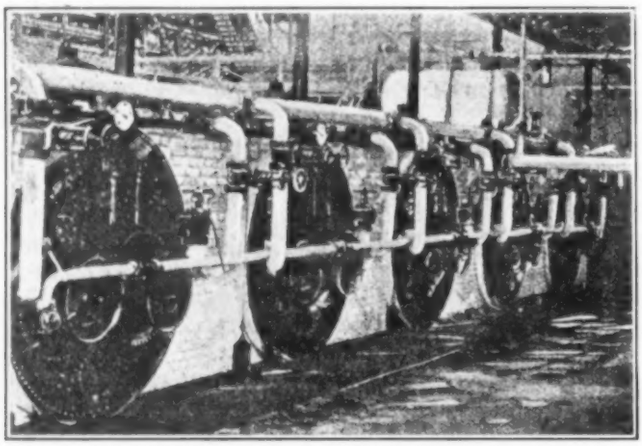


FIG. 4. MODERN OIL-FIRED BOILER INSTALLATION

Although the patents, especially those referring to lixiviation, have not proved successful in practical application, some have led the way to partial improvements.

Among the patents which have been experimented on and which promise to become practically successful, there is one which deserves especially to be mentioned. It is that of two Chileans, Messrs. Prieto and Matus. The fundamental principle of this patent is to attach to the evaporating tank a mechanical arrangement consisting of high-speed rotating horizontal shafts provided with paddles. These paddles "skim" the surface of the liquor, the skimmed liquor is "atomized" and a strong current of hot gas carries away the moisture from the atomized products, thus effecting instantaneous "concentration."

Need of a Technical Organization

The main reason, and it might be said the only reason, why the great efforts illustrated by the vast amount of patents have not been more successful is that there does not exist a technical organization commensurate with the importance of the industry, to collect the useful data of past and present experience in the industry and co-ordinate them to serve as guides for further progress. Such an organization is what is most needed at present to reduce the cost, increase the efficiency and put the Chilean nitrate industry on a technical footing which could be compared with that of the competing industry of synthetic nitrogen products.

Economic Importance of the Different Stages of the Nitrate Industry

The following table shows the extreme variations in the distribution of the cost from the mine to the drier per unit of nitrate produced:

	Per Cent
Mining	22–35
Transportation to the plant	10–15
Operation at the plant	60–45
General expenditures	8– 5
	100–100

If instead of figuring on the unit of nitrate the comparison is made on the basis of the caliche treated, the above figures become:

	Per Cent
Mining	29
Transportation to the plant	17
Operation at the plant	49
General expenditures	5
	100

These figures relate to pre-war costs. With the present cost of fuel the distribution of the price per unit of nitrate is about:

	Per Cent
Labor	42–25
Fuel	50–60
Water	5–10
Material, upkeep	3– 5
	100–100

A summary of the cost figures in percentages showing the economic importance of each stage of the operation is as follows:

	Per Cent
Supervision	1.5– 3
Crushing, transportation	6 –10
Lixiviation	3 – 5
Ejection of refuse	6 –10
Crystallization	1 – 1
Drying, etc	1.5– 4
Fuel (total)	50 –60
Water	4 –10
Material for repairs	3 6
Shop work	5 – 7

Problems to be Considered in the Future Chilean Nitrate Industry

Reserves of Caliche. Up to now there has not been made any elaborate survey of the nitrate zone. The following figures give what according to reliable authorities might be considered as being the total workable raw nitrate in the Chilean nitrate fields with the percentages of caliche:

Millions of Tons of Raw Nitrate	Percentages of Caliche
9	45–38
18	38–32
32	32–25
51	25–18
80	18–10
130	10– 8
320	

These figures would indicate that at the pre-war rate of consumption the reserve is sufficient to provide for the world's consumption for more than 100 years.

FIG. 5. CRYSTALLIZING TANKS

Water. At present from 200 to 300 l. of water are required per metric quintal of nitrate, which indicates that from 10,000,000 to 12,000,000 tons of water is needed annually to supply the nitrate industry. This amount is amply available from the Rio Loa and

especially from the underground waters which according to the exploration results are abundant in the region. But the technical problem to be solved is the purification of this underground water, because it contains 0.1 to 0.3 per cent and even as high as 1 per cent of sodium chloride besides chlorides and carbonates of magnesium and calcium, which are scale producers and very harmful to the life of the boilers and evaporators.

Fuel. The present annual consumption of fuel, including that required by the railways of the region, amounts to more than 300,000 tons of coal and 800,000 tons of oil, all of which have to be imported. A point which requires special study is that although theoretically only about 200 calories would be required for the recovery of 1 kg. of nitrate, in reality more than 1,100 calories are used now per kg. of nitrate.

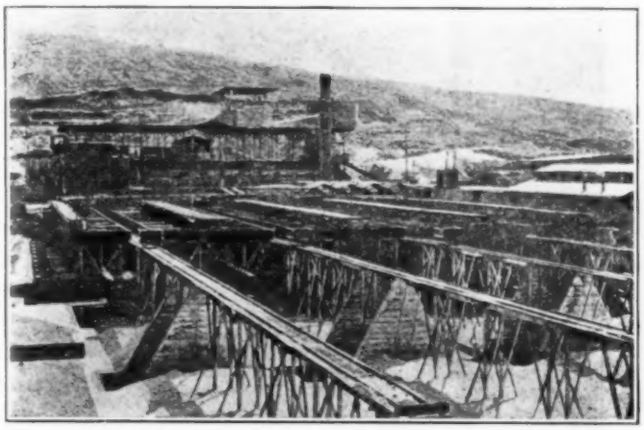


FIG. 6. GENERAL VIEW OF DRIERS

Steam and Mechanical Energy. The more economical production of high pressure steam (source of energy) and of low pressure steam (source of heat), the substitution of heating by gas, the utilization of the Rio Loa hydraulic power (4 cu.m. per sec. with a head of over 1,500 m.) constitute as many problems to be solved.

With a caliche of 18 per cent nitrate, the consumption of energy is 1 kw.-yr. per 1,000 tons of nitrate.

The uses of the energy may be classified as follows:

	Per Cent
Crushing, transportation	70
Circulation of liquids	15
Shops	5
Light	10

Until a few years ago every plant had its own electric power house. Now there are a few central stations supplying the needs of the region. Much remains to be done in the erection of hydro-electric or thermo-electric central stations.

Substitution of Mechanical Power for Hand Labor. The substitution of mechanical power for hand labor has not shown any economical improvement, although a laborer who was paid 3 f. (about 60c.) per day in 1900 and about 6 f. (about $1.20) per day in war time gets even more now, but it may be expected that in the near future mechanical appliances instead of manual labor will find wider uses in the Chilean nitrate industry.

Other Problems. Among the other problems to be considered are: Preliminary treatment at the mine, lowering the percentage of waste, efficient evaporation in the air, making the fractional crystallization and drying operations rapid, automatic and continuous, better uses of gravity railways, shipment of nitrate in blocks or briquets instead of in sacks.

Durability of Electric Heaters for Gasoline Distillation*

BY W. A. JACOBS† AND E. W. DEAN‡

THE petroleum division of the Bureau of Mines, in its laboratory investigations, has had occasion to develop a number of types of electrical heating equipment. It was found that electric heaters could be used to particular advantage in the standard distillation test for gasoline.[1] In order to assist in rendering this type of heater available for general use, a description of the apparatus developed by the Bureau was published.[2] Shortly after the article was printed a chemical supply house undertook the manufacture of an electric heater suitable for gasoline distillation. A preliminary model was examined and tested by the Bureau and modifications were suggested that were incorporated in the type of heater that was finally marketed.

The electric heater developed by the Bureau has an inverted conical resistance element surrounded by a layer of heat-insulating material and mounted in a metal case having a top of hard asbestos (Transite) board. The resistance element is a helix of nickel-chromium alloy wire held by a molded core of alundum. The Bureau heaters are generally of about 330 watts capacity and are used with stock types of regulating rheostats capable of reducing the effective wattage to about one third the full-load maximum.

The commercial heater has a helix of nickel-chromium alloy wire resting in a spiral groove cut in a depression in a block of heat-insulating composition. The coils of wire are held in place by a special cross of sheet mica. The combination of resistance element and heat-insulating layer is mounted in a metal case which also incloses a regulating rheostat. The full-load capacity of this heater is about 260 watts.

COMPARISON OF THE BUREAU OF MINES TYPE AND COMMERCIAL TYPE OF HEATERS

Both types of heaters have been used in the Bureau laboratories, and are capable of doing about the same work. The lower apparent capacity of the commercial heater is compensated for by its greater thermal efficiency, which is due to the detail of construction involving coils held lightly by grooves in a block of heat-insulating material. The commercial heater was somewhat more satisfactory to use, because of its more rapid response to changes in current, as controlled by the rheostat, and because of the latter's convenient location.

Tests have been made to determine the life of the two types of heaters, each operated at full-load capacity. The results were briefly as follows:

	Amp.
Commercial heater:	
Initial current consumption with 110-volt alternating current	2.3
Current consumption, end of 500 hr. running	2.1
Burned out after exactly 500 hr., apparently because the insulating block had disintegrated so that the coils of wire short-circuited.	
Bureau of Mines heater:	
Initial current consumption with 110-volt alternating current	3.0
Current consumption at end of 500 hr.	2.4
Burned out at end of 505 hr., apparently because one small length of wire overheated.	

*Reports of Investigations, U. S. Bureau of Mines.

†Assistant Chemist, Bureau of Mines.
‡Organic Chemist, Bureau of Mines.

[1]Dean, E. W., "Motor Gasoline, Properties, Laboratory Methods of Testing and Practical Specifications," Bureau of Mines Technical Paper 214, 1919. 33 pp.)

[2]Dean, E. W., "A Convenient Electric Heater for Use in the Analytical Distillation of Gasoline," *J. Ind. Eng. Chem.*, vol. 10, 1918, p. 823.)

These results indicate that under conditions of the test the two heaters were practically equal in durability. The commercial heater failed evidently from deterioration of the insulating block, whereas the Bureau of Mines heater failed from destruction of the resistance wire at one spot, where overheating may have occurred or where the wire may have been defective. The slow deterioration of wire in the commercial heater, which is also indicated by a smaller falling off in current consumption, was to have been expected on account of the lighter load it had to carry.

In actual service, the commercial heater probably would have burned out in a relatively shorter time than under test conditions because disintegration of the insulating block would have been accelerated by movement and jarring. The Bureau heater, on the other hand, failed through destruction of the wire, which would not have been accelerated by movement.

SUMMARY

A Bureau of Mines electric gasoline distillation heater and a commercial device sold for the same use were subjected to life tests at maximum current load. Each failed at the end of approximately 500 hr., the Bureau heater through deterioration of the resistance wire, and the commercial heater through disintegration of the block of insulating material holding the resistance wire.

The commercial heater probably would have failed in actual service in somewhat less time than the Bureau heater.

The life of either heating element would not necessarily be the same in actual service as under the conditions of the test described, but is sufficiently great to render the cost of replacements a negligible part of the expense of making distillation tests on gasoline.

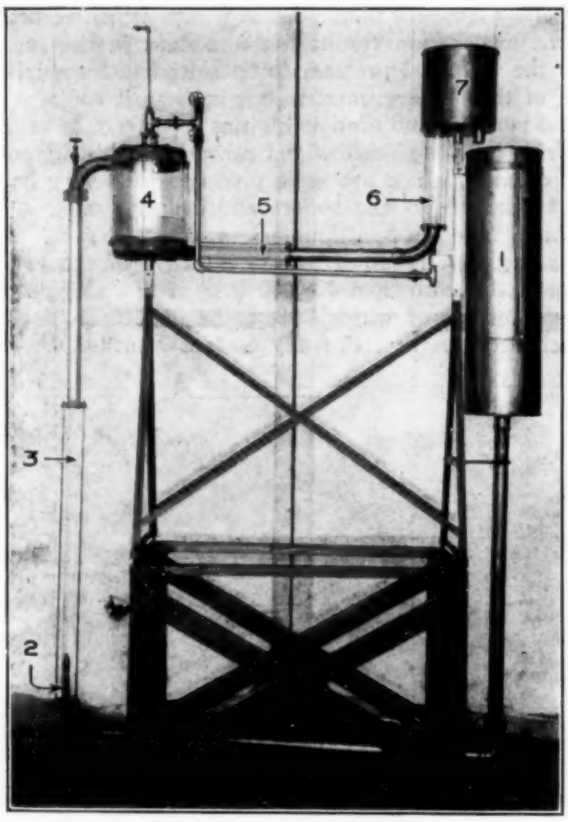
Air Lift Pumping

The wide application of the air lift pumping principle to the handling of acids and chemical solutions as well as of water from deep wells promotes a constant interest in anything regarding this system of pumping.

At the Chemical Industries Exposition in New York next month, the Sullivan Machinery Co. will show an operating model of its air lift system, illustrated by the accompanying cut.

This model is operated by a small, vertical, air-cooled air compressor, belt driven by a ½-hp. electric motor. In this model the well or other source of supply is represented by the vertical copper chamber 1. Water flows by gravity from this through the pipe at the bottom of the model, over to the riser 3, which is made of glass to show the operation of the lift. Air is introduced into this riser or eduction pipe at the base through the Sullivan footpiece or pump 2, which is a taper brass fitting with numerous holes, to permit the discharge of the water upward. In handling acid or other chemicals this part is made of resistant material such as cast iron, cast steel, hard rubber or lead. The water in the eduction pipe, being aërated by the introduction of air, rises in the tube into the chamber 4, which is a model Cyclone Booster made of glass. The air is given a swirling motion by the introduction of water at a tangent to the circumference of the chamber; this has the effect of separating the air from the water.

A certain portion of the air is permitted to escape through a vent valve, the remainder exerting a back pressure on the water in the Booster chamber and forcing it along the horizontal discharge line 5. Frequently in actual practice discharge above the surface is desired. The Booster is able to handle work of this sort, using the same air which raised the water or acid from the pump or well. To assist this action, particularly in cases of high discharge, an auxiliary jet or re-lift jet 6 is frequently used. In this case a portion of the air from the Booster is carried in a pipe parallel to the discharge line, as shown in the model, and introduced into the riser by means of a small pump or foot-piece, which is also shown. The tank 7 represents the storing station or collecting tank, from which the water or acid is handled by gravity or other pump to its final destination.



MODEL OF AIR LIFT PUMPING

Dominion Oxygen Co., Ltd., Completes Initial Plant

The sensational development of Canadian industries in pre-war days was a weak and toddling growth compared to the mighty strides the Dominion is making industrially today. From 1905 to 1915 the capital invested in Canadian factories increased more than 135 per cent and the value of factory products advanced roughly from $700,000,000 to $1,400,000,000. It would be rash to attempt an estimate of Canada's industrial growth since 1915, but it is not a guess to assert that the Dominion has forged ahead industrially as never before in its history.

One of the most important recent announcements bearing on Canada's future industrial development is that of the Dominion Oxygen Co., Ltd.'s, promised erection of a chain of great oxygen plants for separating oxygen from the atmosphere. These plants will be situated in five of the Dominion's industrial centers, and service stations will be established throughout Canada to supply oxygen users wherever there is a demand for the gas, either on or off the railroad.

The first of these plants has already been completed at Toronto, and it is said to be the largest oxygen plant ever built in Canada. It will supply the Canadian market through an extensive warehousing system, pending the erection of the additional plants. The sites for these additional plants have been secured at Montreal, Winnipeg and other points, so that the work of construction may be prosecuted as rapidly as possible.

A Laboratory High-Temperature Coke-Resistance Electric Furnace

By W. Faitoute Munn

FROM time to time variously constructed furnaces heated by means of an electric current are required for laboratory research. Most of them are heated by wrapping a layer of wire, of high melting point, around the refractory substance and then passing the current through the resistor until the desired temperature is obtained. It is obvious that the maximum temperature from such a furnace depends chiefly upon two things—namely, the melting point of the wire used as the heating element and the nature and the melting point of the refractory substance with which the wire is in contact. The result is that temperatures often desired in the experimental laboratory cannot be obtained by this means or type of furnace. As the setting up of the larger and greater capacity electric furnaces usually requires special wiring and considerable expense, the work is generally abandoned and perhaps an excellent idea is set aside.

For temperatures up to 1,500 deg. C. there is not much difficulty in obtaining or making a laboratory electric furnace. For temperatures of 1,800 deg. C. and higher not much information has been given as to the construction of a furnace on a laboratory scale which will not only be inexpensive to make and to operate but also be easily raised to the maximum temperature in a minimum of time.

S. A. Tucker[1] has described a granular carbon-resistance furnace designed for 30 to 35 kw. which in general is similar to the one about to be described, but which would not be convenient for a small laboratory. The voltage, controlled by means of varying the field winding of the alternator, is excellent if the energy is produced in the immediate vicinity of the furnace, but if this is not possible, the alternative, using an auto transformer or an impedance coil for resistance, adds to the bulk of equipment and to the cost of installation.

The Borcher furnace[2] also probably belongs to this class of furnace, but instead of being heated by means of coke particles, the temperature is obtained by passing the current through a small carbon rod connecting the graphite electrodes. This arrangement wou'd not be the proper one for heating substances in crucibles.

A convenient laboratory electric furnace for temperature up to 2,300 deg. C. is that of the granular coke-resistance type using 1-in. graphite electrodes and a 1½-in. graphite crucible.[3] The rods, which are supported by suitable sized pipe-fittings, pass through Silocel brick and continue to within about 1½ in. of the crucible. Granulated coke is used to fill the space around the graphite electrodes and crucible. The graphite crucible is made by sawing off a length of graphite rod of desired diameter and drilling out the center by means of a lathe or with a wood bit of 1-in. diameter by hand. The entire furnace is constructed of 9 x 4½ x 2½ in. Silocel blocks.

The furnace is heated by means of an air-cooled, step-down 2.5 kva. auto transformer. The primary is wound for 220 volts, having eight different taps for connections which enable a voltage range of from 20.7 to 38 volts on the secondary. This arrangement does not require the use of any outside resistance, as the current and temperature are controlled by means of the various contacts on the primary winding and also by varying the pressure of the electrodes on the granulated coke between the electrodes and the crucible. The transformer is connected to the furnace electrodes with stranded No. 0 copper cable.

The voltage and corresponding amperage for the eight steps on the primary winding are as follows:

Volts	Amp.	20 per Cent Overload, Amp.	Volts	Amp.	20 per Cent Overload, Amp.
38—	65	78	27.5	90	108
35—	71	85	25.2	100	120
32.7	76	91	22.8	109	130
30—	83	100	20.7	120	144

The amperes as given in the 20 per cent overload column may be drawn for short intervals (20 to 30 min.) without disastrous results on the transformer.

Temperatures as high as 2,200 to 2,300 C. have been obtained with the above, from a cold start, in 20 min. The cost of running is not over 30c. an hr. figuring 10c. a kw.-hr.

East Orange, N. J.

[1] "A Granular Carbon Resistance Furnace," by S. A. Tucker, *Trans.*, Amer. Electrochem. Soc., vol. 11, p. 307 (1907).

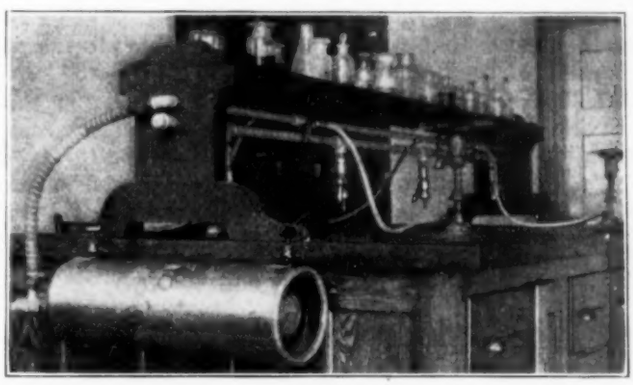
[2] "The Borcher Furnace," by F. A. J. FitzGerald, *Electrochem. & Met. Ind.* (1905), p. 215.

[3] If graphite should be injurious to the substance being heated, the crucible may be lined with MgO, CaO, Al_2O_3, ZrO_2, etc., to prevent any action which might be caused by carbon.

Use of Acetylene in Chemical Laboratories

The use of acetylene in chemical laboratories is rendered convenient by the adoption of an equipment placed on the market by the Prest-O-Lite Company.

The acetylene flame is sufficiently hot to bring about chemical reactions in the most refractory of substances, is economical and is ideal for convenient handling. The equipment is very compact, comprising only the familiar



LABORATORY EQUIPMENT FOR THE USE OF ACETYLENE

Prest-O-Lite tank and flexible hose to connect it to the burner. Used with the bunsen burner, acetylene produces an intense local heat exceeded only by the electric arc and the oxy-acetylene flame, and if it were desired to use the oxy-acetylene flame it would be necessary only to add a cylinder of oxygen, reducing regulator and blowpipe. When the gas is exhausted the acetylene tank is detached and a full tank is put in its place.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacture of Carbon Dioxide.—Very little has been published concerning the methods used in the United States for the production of carbon dioxide. Since it is estimated that over 100,000,000 lb. of liquid CO_2 is produced annually in the United States and Canada, the following outline of the process of manufacture, from a paper by G. H. TOMLINSON in the *Canadian Chemical Journal* for July, 1920 (p. 189), will undoubtedly be of interest:

The coal or coke used in its production is burned in the usual way under steam boilers, thus furnishing not only the raw material of manufacture but also all the power required for its purification and liquefaction. The flue gases leaving the boilers are first passed through an economizer to reduce their temperature and then through scrubbers to remove dust and sulphur dioxide. From these they go to an absorption system in which contact with an alkaline carbonate solution is effected and as much as possible of the CO_2 combined. The carbonated lye is drawn from here and pumped through a heat regenerator. It is then passed to the economizer, and, following this, is used to condense the steam given off with the CO_2 during the final heating. Its temperature is thus raised to the boiling point by otherwise waste heat alone. The "boiling off" is effected by utilizing the exhaust steam from the compressors, etc., which in a properly balanced plant is sufficient to maintain the necessary heat balance. The decarbonated or exhausted lye returns through the heat regenerator, giving up its heat to the carbonated lye, before again passing to the absorption system to renew the cycle just described.

The CO_2 which is liberated from the boiling bicarbonate solution is separated from the steam as previously noted, and after further cooling is compressed into the cylinders in which it goes to the trade.

From this description it can be seen that the two main objects to be accomplished for the successful working of the process are:

1. The recovery from the combustion gases of the maximum amount of CO_2 by bringing this into combination with the alkaline carbonate.
2. The maximum dissociation of the bicarbonate thus formed with the minimum consumption of heat.

A study of the reversible reaction

$$Na_2CO_3 + CO_2 + H_2O \leftrightarrows 2NHCO_3$$

requires measurements of the dissociation tension of CO_2 for bicarbonate solutions at various temperatures. While such data are available for pure solutions of sodium and potassium bicarbonates (see accompanying table), in the commercial process mixtures of carbonate and bicarbonate containing from 30 to 75 per cent of the latter are encountered. Complete dissociation tension-temperature curves for such mixtures have not been determined. However, it is possible to make certain general deductions on the assumption that the dissociation tension will be higher as the temperature and the proportion of bicarbonate increase.

Let x = pressure of CO_2 in combustion gases entering absorption system.
x_1 = pressure of CO_2 in waste gases.
y = CO_2 tension of exhausted lye solution.
y_1 = CO_2 tension of carbonated lye.

The best recovery of CO_2 from the combustion gases will result when x is a maximum and x_1 a minimum. Similarly, the most favorable conditions for recovering CO_2 from the lye solution are y_1 a maximum and y a minimum. Now x will normally have its greatest value when the percentage of CO_2 in the gases approaches 20 and y will have its lowest value the more completely the lye is boiled and the lower the temperature at which absorption is commenced. In order to conserve heat the volume to be boiled must be reduced as much as possible by using concentrated lye solutions. The highest efficiency will be obtained when $x = y_1$ and $x_1 = y$. In practice this results when sufficient time is provided for the absorption (which should be conducted on the counter-current principle) and when the amount of carbonate present is exactly adjusted to the amount of CO_2 available.

DISSOCIATION TENSION OF BICARBONATE SOLUTIONS

Temp. Deg. C.	Dissociation Tension $NaHCO_3$ mm. Hg	Dissociation Tension $KHCO_3$ mm. Hg
15	120	461
30	212	...
40	356	...
50	563	...

From the accompanying table it will be seen that y is lower for sodium bicarbonate than for potassium bicarbonate. However, the limited solubility of the sodium salt is a disadvantage and a mixture of the two salts is found to be more efficient than either alone.

Theoretically, 1 lb. carbon should yield 3.66 lb. CO_2. Commercial results vary between 1 and 1.5 lb. CO_2.

On the Oxidation of Coal.—During the last few years a number of chemists have worked on the problem of determining facts which might help to establish the constitution of coal. The theory now predominating is that coal contains three constituents; namely, compounds of lignocellulose, proteins and resins. It is also known that pyridine dissolves only the resinous constituent. It has also been determined that coal oxidizes slowly in the cold, more rapidly at 100 deg. C., and that by this oxidation the coal loses its coking property. Boudouard attributes the coking power of a coal to a substance or a group of substances which by oxidation form humic products soluble in potash and giving a brown solution. According to recent theories the oxidation is produced by the intervention of special bacteria which start the reaction.

MARCEL GODCHOT has studied the mechanism of the oxidation of coals and presented the results of this work to the French Academy of Sciences (*Comptes rendus*, July 5, 1920, pp. 32-34). He worked on Blanzy coking coal of the following composition: 37.4 per cent volatile matter, 58.6 per cent fixed carbon and 4 per cent ash. The ultimate analysis on the ash-free basis is: Carbon 83.59 per cent, hydrogen 5.78 per cent and oxygen plus nitrogen 10.67 per cent. A 100-g. sample of the coal was treated with boiling pyridine. The brown amorphous pyridine extract obtained weighed 22.63 g. and its composition was: Carbon 83.45 per cent, hydrogen 5.84 per cent and oxygen plus nitrogen 10.51 per cent. Comparing these figures with those for the original sample, it is seen that

their compositions are quite identical. An important fact is that the coal after extraction with pyridine cannot be coked, but by mixing this coal with the pyridine extract the product becomes again just as good a coking coal as the original sample.

Samples of the original coal, of the coal extracted with pyridine and of the pyridine extract were kept for one month in an oven at 100 deg. C. The increase in their weight was respectively 3.15, 1.99 and 1.22 per cent. A mixture of an extracted sample of coal with its pyridine extract submitted to the same heat for the same length of time showed an increase in weight of 3.20 per cent, which is identical with the increase in weight of the original coal. All these oxidized samples give with potash a brown coloration.

After a study of these facts it is difficult to admit that the oxidation of the coal is the result of the action of bacteria pre-existing in the coal, because pyridine is a strong antiseptic, and still the pyridine-extracted coal, the pyridine extract and their mixture are readily oxidized. It seems that pyridine has broken up the coal into two separate oxidizable parts, of which one part plays the role of an oxygen carrier because the original coal and the reconstituted mixture oxidize more rapidly and in greater proportion than the two parts separated by pyridine treatment. The coking property of the coal is due to the constituent which can be extracted by pyridine—i. e., to the resinous constituent of the coal.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Sulphur Dioxide.—The removal, and subsequent disposal, of sulphur dioxide from the gases of metallurgical plants is a problem which is becoming increasingly important. The production of sulphuric acid from these gases is not difficult, but sulphuric acid is a cheap and bulky commodity, the sale of which is confined to local markets; and its use, except in particular sections of the country, is limited as to quantity. The demand for liquid sulphur dioxide in manufacturing processes is increasing. Sulphur has a broader market than sulphuric acid and has the advantage of being more easily handled. Liquid sulphur dioxide is easily produced from concentrated sulphur dioxide gases by direct compression, and the direct reduction of concentrated sulphur dioxide gas to sulphur with coke is comparatively easy. For these reasons the production of concentrated sulphur dioxide gases in metallurgical operations is desirable.

FREDERICK LAIST and FREDERICK F. FRICK of Anaconda, Mont., purpose to produce concentrated sulphur dioxide gases in a practical and economical manner in such metallurgical operations as roasting, nodulizing and sintering and in blast-furnace and converter practice by supplying oxygen diluted with sulphur dioxide instead of air during these operations. The intense action of pure oxygen on sulphide materials is avoided by returning to the furnace a portion of the gases evolved in the roasting operation, the oxygen being added to the cyclic gas in a regulated quantity. Concentrated sulphur dioxide gas may be produced by this method from the usual types of metallurgical furnaces with the addition of comparatively cheap and simple equipment. (1,344,905; June 29, 1920.)

Hydrometallurgical Recovery of Copper by the Use of Iodine.—ARTURO A. OSSA, of Valparaiso, Chile, has invented a process for the recovery of copper from copper-bearing minerals with the simultaneous production of sulphuric acid. The process steps constitute a closed operating cycle in which iodine is an essential and recoverable reagent, being based primarily upon the interreactions between solutions of copper sulphate and hydriodic acid in the presence of sulphurous acid. In this reaction a precipitate of cuprous iodide is formed and sulphuric acid set free. The iodine is eventually recovered in a form for reuse in the process and the sulphuric acid is available for leaching oxidized copper ores for the preparation of additional copper sulphate. The sulphur dioxide is ultimately oxidized to sulphuric acid and is also available for leaching. The operation comprises three principal steps:

1. Preparation of hydriodic acid solution. This is conveniently effected by suspending pulverized iodine in water in a closed tank and subjecting it to a current of sulphuric dioxide; or a mixture of iodine vapor and sulphur dioxide may be passed upward through a tower filled with inert material and sprayed with water. The reaction is as follows:

$$SO_2 + I_2 + 2H_2O = H_2SO_4 + 2HI$$

2. Precipitation of cuprous iodide. A solution of copper sulphate, preferably concentrated, is saturated with sulphur dioxide in order to prevent the precipitation of iodine during the subsequent reaction. Sufficient hydriodic acid prepared as described is added to completely precipitate cuprous iodide. The reaction is as follows:

$$2CuSO_4 + 2HI + SO_2 + H_2O = Cu_2I_2 + 3H_2SO_4$$

3. The regeneration of the iodine. The precipitate of cuprous iodide is removed by filtration, washed and then dried by gentle heating. The dried precipitate is mixed with approximately 20 per cent by weight of cupric oxide and the mixture calcined in a closed furnace under oxidizing conditions. The cuprous iodide is transformed into cupric oxide and the iodine set free. The reaction is as follows:

$$Cu_2I_2 + nCuO + O_2 = (n + 2)CuO + I_2$$

The liberated iodine sublimes and is treated for the regeneration of hydriodic acid solution. (1,343,153; June 8, 1920.)

Recovery of Copper From Oxidized Ores.—Oxidized ores of copper are not ordinarily amenable to flotation, and the presence of oxidized minerals in sulphide ores prevent the flotation of a portion of the sulphide particles. Sulphide copper minerals are not soluble in ordinary solvents such as sulphuric acid; on the other hand most oxidized copper minerals are soluble in this reagent.

W. E. GREENAWALT, of Denver, Col., takes advantage of these facts in working out a process for the recovery of copper from ores containing both oxidized and sulphide minerals, of which there are large deposits in the Western states. The ore is pulverized and treated with a dilute solution of sulphuric acid in amount sufficient to dissolve the oxidized copper. The acid pulp in which the sulphides are practically unaffected and

the oxides partly or totally converted into sulphate is agitated with flotation oil and the mixture introduced into an electrolytic cell in which it is subjected to electrolysis and flotation. The gas generated by electrolysis assists in floating the sulphide minerals and by using a high current density a non-adherent copper deposit is obtained on the cathodes; this is floated with the sulphide particles. During electrolysis sulphuric acid will be regenerated dissolving more copper and the ferric salts which are formed will be reduced by the action of the minerals in the pulp. (1,344,127; June 22, 1920.)

Potash Recovery by Metathetical Reactions.—Potash is widely distributed in combination with silica in igneous rocks such as granite, gneiss, feldspar, greensand and leucite, but is recovered with difficulty from such materials, and at an expense inadmissible for use as commercial fertilizers. A common method consists of fusion with relatively expensive chemicals. Such a method is expensive and difficult to conduct mechanically.

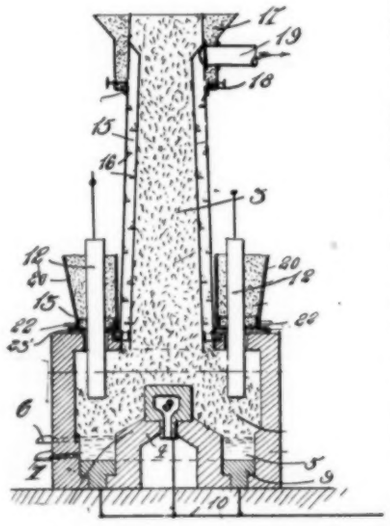
ARTHUR C. SPENCER proposes to utilize the mass action principle for the recovery of potash from potash bearing rocks by treating them with a solution of salt in excess of the potash equivalent in the material, utilizing heat and pressure to hasten the reaction, having found that the substitution of the potassium in the rock by the sodium in the salt proceeds quite readily in aqueous solution at temperatures corresponding to 150 to 300 lb. steam pressure. For instance, heating glassy basalt with a solution of sodium chloride in amount and strength so that somewhat more than two equivalents of sodium are present in the zone of reaction for each equivalent of potassium in the mineral for six hours at 200 deg. C. will result in the substitution of practically all of the potassium in the mineral. It is desirable that the rock be of an amorphous variety, otherwise it is better to heat the material sufficiently to destroy the normal molecular or the crystalline structure, or both.

Certain advantages arise by the use of ammonium chloride and ammonia to bring about the reaction: the reaction proceeds at a lower temperature and a smaller amount of ammonium chloride need be employed, only a small excess over the amount equivalent to the extractable bases being required; the unconsumed ammonia is easily recovered and the excess of ammonium chloride may be decomposed by lime; the amount of water employed can also be greatly reduced. Crude ammonia salts can be used, such as byproducts from coke-oven flues, forming an outlet for the material, which does not require such fixation reagents as sulphuric acid. The ammonia will be fixed in the mineral matter as a result of the metathetical reaction. This can be recovered by heating or the material may be used as a fertilizer. The potash recovered from the solution can be added to this material, which then requires but the addition of phosphate in some form to make a complete fertilizer.

Sodium carbonate or bicarbonate can be used if the escape of carbon dioxide be prevented, and it is possible to use natural brines. In this way such brines, if they contain small amounts of potash, may be enriched. (1,344,830; June 29, 1920.)

Devulcanizing Rubber.—CYRUS F. WILLARD, of San Diego, Cal., has developed a process for devulcanizing rubber which involves certain interesting principles of colloid chemistry. Assuming the "combined" sulphur to be adsorbed by the rubber, the inventor treats the finely ground rubber with another emulsoid colloid solution (such as wood tar emulsified in water) which has a greater affinity than the rubber for sulphur. A sulphur solvent such as turpentine is added and the mixture boiled either in an open kettle or under pressure. Under the influence of the heat and the sulphur solvent, the "combined" sulphur is liberated from the rubber and immediately adsorbed by the tar emulsion. The latter is easily removed from the remaining devulcanized rubber by treatment with 3 per cent caustic soda solution. The whole process may be carried out in one or two steps, as desired. It is claimed that over 50 per cent of the combined sulphur is removed, so that the properties of the recovered material closely approach those of the original rubber before vulcanization. Furthermore, in the case of scrap containing fabric or fiber, devulcanization takes place without destroying the fiber, which can subsequently be separated, if desired. (1,322,077; 1,322,151; 1,322,152; Nov. 18, 1919.)

Electric Zinc Furnace.—FRANCOIS LOUVRIER, of Paimbœuf, France, proposes to produce zinc from its ores in an electric furnace, the design of which is shown in the sketch. Zinc ores are fed into the furnace through the central column 3, which is sealed to prevent the inflow of air. In passing down the column the ore is dried by the heat from the liberated zinc fumes which pass up the annular passage 15 and out through pipe 19 to a condenser. Carbon in the form of powdered coal is fed into the annular passage from hopper 17, being retained on the circular shelves 16. The introduction of the coal dust into the reaction chamber in this manner affords the opportunity for the reduction of any carbon dioxide in the escaping gases. Six electrodes, 12, are provided; these enter the furnace through stuffing boxes 20, also filled with powdered coal; a valve, 22, permits the feeding of the coal into the reaction chamber and the close proximity of the coal to the electrode reduces the consumption of the latter. Beneath the electrodes, 12, is an annular hearth, 5, which is electrically connected through electrode 9. A central electrode, 8, is provided. This arrangement of electrodes provides for the uniform distribution of heat through the charge. Slag and metal are tapped through spouts 6 and 7. (1,342,636; June 8, 1920.)



Potash From Silicates.—EINAR BERGUE, of Notodden, Norway, assignor to Norsk Hydro-Elektrisk Kvaolstofaktieselskab of Christiania, has been granted a patent on a process for the reduction of $K_2O.Al_2O_3.6SiO_2$ to $K_2S.Al_2S_3.6SiS_2$ or an intermediate product by heating with sulphur vapors at about 800-1,400 deg. C. These sulpho-silicons or silicates are decomposed by water under pressure, giving soluble potash. (1,346,365; July 13, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Utilizing Slag.—Relates to the utilization of blast furnace slag in the production of bricks, blocks, tiles, slabs, door and window frames, baths, sinks, pipes, conduits, and other parts of workmen's dwellings, garages, bungalows, outbuildings, &c., also electric insulators, electric main conduits, the bed-plates of electric generators, curbing, tanks, etc. The slag is broken up, graded, and filled into molds, which are then filled with molten slag so as to bind the particles of graded slag together. The graded slag may be heated, and the molten slag may be mixed with 10 to 15 per cent of silica, lime, or other binding agent, and also metallic oxides for coloring purposes; or the metallic oxides may be applied to the inner faces of the molds. The molds may also be heated and gradually cooled for the purpose of annealing the product. Instead of using molten slag direct from the blast furnace, the molds may be filled with the graded slag mixed or not with other materials such as soda-ash, cryolite, crushed waste glass, iron silicate, etc., having a lower melting point than the slag, and afterward heated to a temperature above the melting point of the slag. A mold having a double wall may be used, the space between the walls being filled with asbestos or other heat-insulating material. Or the graded slag may be placed in an inner mold surrounded by an outer mold into which the molten slag is poured while the inner mold is simultaneously removed, so that a layer of solid slag is formed around the mass of granulated slag; also molten slag may previously or simultaneously be poured among the granulated slag so as to bind the whole together. (Br. Pat. 140,874—1919. T. F. HOARE, Bradford, Yorkshire, May 27, 1920.)

Treating Wood With Liquids.—A process for lightening the color of veneers of colored wood, in imitation of the effects produced on the same wood by the prolonged action of light so that the veneers may be used for repairing or imitating old furniture, consists in treating the wood in an acid bath, preferably nitric acid, then drying the wood at as high temperature as it will stand without charring, and finally rinsing. Rosewood and purplewood are subjected to a preliminary immersion in oxalic acid and rinsed in warm water before treatment in nitric acid. In order to lessen the visibility of the grain, the wood may be immersed in alcohol for 24 hr. previous to the acid treatment. Mixtures of nitric and hydrochloric acids should be used when reddish effects are desired. Amaranth wood is treated for about half an hour in hot water before immersion in nitric acid. (Br. Pat. 141,052—1919. P. E. SIMON, Beauvais, France, June 2, 1920.

Decarburizing Iron and Its Alloys.—Iron and its alloys are decarburized by heating to a high temperature under oxidizing conditions, and then slowly cooling, for the purpose of increasing the magnetic permeability and reducing the hysteresis loss. A low carbon ferrosilicon, for example, with 4 per cent of silicon is heated at 1,050 deg. C. for 13 hr. in a current of air at a pressure 2 mm. of mercury, and has its carbon content reduced from 0.1 to 0.01 per cent or less. The article may be placed in contact with iron oxide during the treatment, and over-oxidation may be corrected by a further heating under slightly reducing conditions. After decarburizing, the article may be forged or rolled and annealed. (Br. Pat. 141,348—1919. METROPOLITAN-WICKERS ELECTRICAL Co., Westminister, June 9, 1920.)

Acrolein.—Acrolein is stabilized by the addition of minute quantities of phenols, e.g. from 0.1 to 1 per cent of pyrogallol, pyrocatechol, hydroquinone, gallic acid, tannin, etc. (Br. Pat. 141,361—1919. C. MOUREU, C. DUFRAISSE, P. ROBIN and J. POUGNET, all of Paris, June 9, 1920.)

Artificial Leather.—Artificial leather is made from paper, alone or combined with a textile fabric, by treating with a vegetable glue such as is obtained from bananas, or from the farina of *Colocasia esculadium*, mixed with water containing 25 per cent of glycerine, with or without the addition of isinglass, casein, gum damar or other agglutinant. The material is then air-dried and may be dyed. The material so treated may be waterproofed with a mixture containing a vegetable wax such as carnauba, mixed, for example, with paraffine wax and turpentine. A number of sheets may be superposed, and the material may be finished to give it the appearance of ordinary leather. (Br. Pat. 141,385—1919. G. MILLER, Meopham, Kent, June 9, 1920.)

Deoxidizing and Refining Aluminum and Its Alloys.—For deoxidizing and refining aluminum and its alloys, an aluminum cartridge containing potassium phosphide is first added to the metal heated above its melting point to convert the impurities, silicon, iron and oxygen, into phosphorus compounds; then, at a higher temperature, a second aluminum cartridge, containing one of the metals of the alkaline earths or lithium, is added for the purpose of decomposing the phosphorus compounds, which burn at the expense of the alkaline earth metal, and the oxides formed float on the surface of the aluminum. (Br. Pat. 141,324—1919. A. STRASSER, Borschach, Switzerland, June 9, 1920.)

Sulphuretted Dyes.—A black dye is obtained by boiling 1:2:4 dinitrophenol with sodium sulphide solution and sulphur in the presence of phenol or cresols. (Br. Pat. 141,759—1919. H. R. VIDAL, Asnières, France, June 16, 1920.)

Monoazo Dyes.—Monoazo dyes are obtained by coupling an aromatic diazocarboxylic acid with the n-methyl-ω-sulphonic acid derivative of an aromatic aminocarboxylic acid (capable of being coupled and diazotized) and finally eliminating the methyl-ω-sulphonic acid group. The products are mordant dyes, dyeing wool yellow to orange shades and giving similar tints on chrome-printed cotton, and may be used as parent materials for secondary disazo dyes. Examples are given of the preparation of 4-aminoazobenzene-3:3'-dicarboxylic acid, 4-aminoazobenzene-2:3'-dicarboxylic acid, 4-aminoazobenzene-3:4'-dicarboxylic acid, and 4-aminoazobenzene-3:2'-dicarboxylic acid.

N-methyl-ω-sulphonic acid derivatives of the aminocarboxylic acids referred to are prepared by heating a solution of the sodium salt of the aminoacid with sodium formaldehyde bisulphite solution. (Br. Pat. 141,643—1919. SOCIETY OF CHEMICAL INDUSTRY, Basel, Switzerland, June 16, 1920.)

Aluminates.—Sodium, barium, calcium and other alkali and alkaline-earth aluminates.—Calcium aluminate practically free from other oxides is produced by heating bauxite or other aluminum ore with lime and

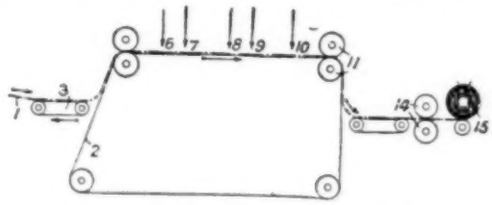
carbon or silicon, aluminum or calcium carbide in an electric furnace, whereby all the foreign oxides are reduced to the metallic state. Acidic oxides, such as those of silicon and titanium, form ferrous alloys which separate at the bottom of the furnace and are suitable for use in the metallurgy of iron. In place of lime, baryta or other alkaline earth may be used. The alkaline earth aluminates are converted into alkali metal aluminates, such as sodium aluminate, $Al_2O_3Na_2O$, by treating their hot solutions with alkali metal carbonates. (Br. Pat. 141,666—1919. ROCHETTE FRÈRES, Savoy, France, June 16, 1920.)

Recovery of Volatile Solvents.—In recovering volatile solvents evaporating during the drying of india-rubber articles and the like, an absorption agent is placed in the drying chamber, and uniformly distributed over it. The agent is preferably made to flow through the chamber, and may be conducted by means of rods, threads, wires, textile fabrics and the like. The solvent is subsequently recovered by distillation or other means. (Br. Pat. 141,739—1919. H. SCHMIDT, Cologne, Germany, June 16, 1920.)

Electrolysis—Zinc and Cadmium.—A precipitate obtained by adding zinc dust, with or without a copper salt, to sulphate solutions prepared from ores containing zinc and cadmium, with or without copper and cobalt, is treated for the recovery of cadmium, zinc, and, if present, copper, in the following manner: If substantially free from cobalt, the precipitate is oxidized and leached with sufficient dilute sulphuric acid to dissolve a maximum of zinc and cadmium and a minimum of copper. From the residue the copper is recovered by smelting or otherwise. Alternatively, the precipitate, oxidation of which is guarded against, may be leached with sufficient acid to dissolve the zinc, the residue being then oxidized and further treated to dissolve the cadmium. In either case, the solution containing the cadmium is treated with zinc dust in quantity insufficient for complete precipitation of the cadmium, which is thus obtained free from zinc. In this treatment, the solution should be slightly acid and air should be excluded as much as possible; about ½ g. of cadmium per liter should remain after precipitation. A further treatment of the solution in a second vat with excess zinc, and preferably in the presence of about ½ g. of copper per liter, gives a zinc solution which is added to the purified ore solution, and a precipitate which can be used again in the first vat. The precipitated cadmium is roasted and dissolved in dilute sulphuric acid or spent electrolyte. Copper is removed by excess of the cadmium precipitate, metallic cadmium, or cadmium oxide, and the solution, then containing about 100 g. cadmium per liter, is electrolyzed with rotating aluminum cathodes at which the current density may be 20 amp. per sq.ft. Glue may be added to the electrolyte in the proportion of 2 lb. for each ton of cadmium produced. The deposit after removal may be melted under caustic soda and potassium cyanide. After electrolysis, the solution should contain 60 g. of acid per liter. An alternative method of separating the zinc from the cadmium consists in agitating the solution with zinc oxide or hydrate at 60 deg. C. for some time, and then cooling to 35 deg. C. so as to precipitate the zinc as basic sulphate. When the original precipitate contains cobalt, it is oxidized and leached with zinc sulphate solution or just sufficient dilute sulphuric acid to dissolve out most of the cadmium and cobalt, and the residue is then treated as in the first case. The solution of cadmium and cobalt is treated with zinc dust as described above so as to obtain zinc-free cadmium, which is added to that obtained from the residue above mentioned, and a solution of zinc and cobalt, from which a pigment may be prepared, for instance by adding sodium carbonate and drying and heating the precipitate. (Br. Pat. 141,688—1919. ELECTROLYTIC ZINC CO. OF AUSTRALASIA PROPRIETARY, LTD., Melbourne, June 16, 1920.)

Color Photography.—In the interference method of color photography, the radio activity of the mercury, silver or other radio-active material used in conjunction with the film is supplemented "instantaneously and simultaneously with the eruption of the rays reflected by the object in the form of electricity, X-rays, light or other form of free energy so as to make up for the normal insufficiency of the radio-activity of these substances made by radiation in the opposite direction from these latter to aid, on the one hand, the extra rapid realization of the equilibrium of the stationary rays, the remainder of the available energy serving to effect the laminar formation of the different complementary colorations corresponding to the rays absorbed by the object, and on the other hand to aid in the prompt formation of the blacks by the process of superposition of unilateral rays in the region of the sensitive film where no ray comes from the object." (Br. Pat. 141,699—1919. P. ELMASSIAN, Paris, France, June 16, 1920.)

Imitation Leather.—In the manufacture of imitation leather, bundles or laps of fibers are led on to an endless conveyor band, and binding, softening and hygroscopic substances are applied to the fibers, which are simultaneously acted upon by a blower to produce a "felting" of the fibers. As shown, fibers 1 from a carding-machine pass over a conveyor 3 to a conveyor 2 and are subjected at 6 to the action of a blower, treated with binding, fatty, and hydroscopic substances at 7, 8, and 9 respectively, then subjected again to the action of a blower at 10, and pass between pressing-rollers 11 and calendar rollers 14 to a roll 15. For producing thicker fabric, the material is passed a number of times around the conveyor 2, or a drum, while fresh fibers are fed from the carding-machine. In another form of apparatus, a number of layers of fibers are fed simultaneously from rolls on to successive parts of an endless conveyor, the fibers of each layer being subjected to the action of a blower and treated with binding and softening or hygroscopic substances. The binding substance may be a solution of cellulose, cuprammonium oxide, glue, etc. (Br. Pat. 141,712—1919. N. ZIGNONE, Milan, Italy, June 16, 1920.)



Ammonium Sulphate.—Neutral ammonium sulphate is prepared by mixing the crystals removed from the saturator with ammonium sulphite or bisulphite, in solid form or in solution, either before or after the crystals have been washed, or by adding ammonium sulphite or bisulphite to the washing liquor. (Br. Pat. 141,799—1919. SOUTH METROPOLITAN GAS CO., London, and O. W. WEIGHT, Bromley, Kent, June 23, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Special Train Service to Chicago for A. C. S. Meeting

The special transportation committee of the New York Section of the American Chemical Society in charge of transportation from Eastern points to Chicago for the general meeting of the American Chemical Society, Sept. 7 to 10, finds that alternative plans can be made for a special car or cars on the New York Central and Pennsylvania lines. Members of the Society who would like to join these special parties at New York or points farther west should communicate immediately with Frank E. Dodge, care of The Barrett Co., 17 Battery Pl., New York City. Space will be reserved upon receipt of telegram or letter together with the necessary remittance.

On the New York Central a special car or cars will leave on Train No. 3, from Grand Central Station, New York City, at 8:45 a.m., Eastern standard time, Sunday, Sept. 5, arriving in Chicago Monday 7:40 a.m., Central standard time. The fares from New York and intermediate points, including extra fare, which is $5.10 from New York, together with Pullman charges, are as follows:

City	Fare	Upper	Lower	Dr. Room	Compartment
New York City	$40.46	$7.78	$9.72	$34.02	$27.54
Albany	31.84	7.13	8.91	32.40	25.11
Schenectady	31.19	7.13	8.91	32.40	25.11
Syracuse	26.10	5.51	6.91	24.30	19.44
Rochester	22.98	4.86	6.10	22.68	17.01
Buffalo	20.31	4.86	6.10	22.68	17.01
Cleveland	13.19	3.24	4.05	14.58	11.34

On the Pennsylvania a special car or cars will be attached to train No. 5, leaving Pennsylvania Station, New York City, at 11:04 a.m., Eastern standard time, Sunday, Sept. 5, arriving in Chicago Monday at 9 a.m., Central standard time. The fares, including extra fare and Pullman, are as follows:

City	Fare	Upper	Lower	Dr. Room	Compartment
New York City	$41.76	$7.78	$9.72	$34.02	$27.54
Philadelphia	36.96	7.13	8.91	32.40	25.11
Baltimore	30.97	7.13	8.91	32.40	25.11
Washington	30.97	7.13	8.91	32.40	25.11
Harrisburg	27.76	6.48	8.10	29.16	22.68
Pittsburgh	18.23	3.89	4.86	17.82	13.77

These fares, figured from the existing tariff by the railroad passenger departments, may vary by a few cents when the official tariff is promulgated. Trains on either line will arrive in Chicago in time for the meeting of the directors and advisory committee at 12:30 p.m. and the council meeting at 4 p.m.

Alpha Chi Sigma to Meet in Chicago

The chemical fraternity Alpha Chi Sigma will hold a meeting in Chicago coincident with the meeting of the American Chemical Society in September. A banquet will be served at the Morrison Hotel at 6:30 on Wednesday evening, Sept. 8, and a business meeting will follow. Members of the fraternity are requested to register at a place provided for that purpose at the headquarters of the American Chemical Society, Congress Hotel.

Application of Government Research to Be Fostered

In announcing the appointment of David J. Price as chief of the office of development work in the Bureau of Chemistry, Dr. C. L. Alsberg, chief of that Bureau, makes the following statement:

> The practical application in the industries and in the arts of scientific research is quite a different matter from the doing of the research itself. It requires rather different talents and an objective point of view which the scientist in his enthusiasm may not always have. If it be a matter involving manufacturing, for example, it requires the calculation of costs, which is really usually an engineering problem, and which in many cases can best be done by someone without the bias of authorship. In short, it is rather an engineering business problem than a problem of science.

It is expected that the work to be undertaken along these lines by Mr. Price will afford both the industries and the investigators of the Bureau added facility for co-operation in the application of research conclusions that have possible industrial value. It is hoped that any industry finding valuable conclusions in the work will thus be aided to a prompt realization of the technical possibilities from an engineering as well as a laboratory point of view.

Another important aspect of this is also emphasized by Dr. Alsberg when he says: "I believe that by such an arrangement as is proposed herein much of the Bureau's work can be made effective and that the investigators of the Bureau may be made free to prosecute their researches and not waste unnecessary time in establishing industrial contacts."

It has not yet been determined what particular problems will first be attacked by this new office, but the work will go forward early in the fall.

Water-Power Rules and Regulations

The rules and regulations to be used in connection with the administration of the water-power act are being perfected. The regulations were the subject of two public hearings, at which the draft was criticized and suggestions made. The committee of the Federal Power Commission, together with a committee representing outside interests, is working out the moot points in order that the regulations may be promulgated in the near future.

The financial interests made an especially urgent plea that in framing the regulations, sight should not be lost of the fact that, at best, it is going to be difficult to interest capital, under present conditions.

Bureau of Mines Creates New Division

F. G. Cottrell, director of the Bureau of Mines, has authorized the creation of a division on non-ferrous metallurgy. A. E. Wells, who has been a member of the Bureau's staff for many years, will be in charge of the new division with the title of chief metallurgical engineer. The headquarters of the division will be maintained in Salt Lake City.

October Meeting Electric Furnace Association

The subject of Refractories has been selected for the session of the Electric Furnace Association which will be held in Columbus on Wednesday afternoon, Oct. 6.

The meeting will provide an opportunity for a discussion of their problems by the users and makers of refractories. Papers will be presented by steel men and by the manufacturers of bricks and lining materials, and considerable time will be allowed for questions and informal discussion.

Some other interesting features are being arranged for the meeting so that it should be a considerable addition to the progress of activities already planned for the first week of October in Columbus.

The Electric Furnace Association plans to hold its session in one of the buildings of the Ohio State University.

The British Paper Industry

British paper makers are making extensive plans to meet the ever-increasing demand for paper. Because of the uncertainty of business due to war conditions and the lack of raw materials, all previous measures had to be delayed till a more propitious time. Conditions, however, have very much improved since the armistice and the companies are fast recovering from the effects of the war.

The Imperial Paper Mills, Incorporated, is offering to investors £800,000 of 7½ guaranteed 15-year first mortgage debenture stock at 93 and redeemable at 103. This stock is secured by a first mortgage on mills and property at Gravesend on the Thames and on shares of a Canadian company.

The Imperial Mills was organized to supply the requirements of the Amalgamated Press, Ltd., in the production of its seventy periodicals and magazines and also the large amount of paper necessary for the printing of the *Times*, the *Daily Mail*, the *Daily Mirror*, the *Sunday Pictorial* and other papers. Originally the mills were designed with a weekly capacity of 1,500 tons. This output, however, is to be increased to 1,800 tons per week in the new plans.

Canadian Pulp Mills Purchased

The Imperial Co., together with Lord Rothermere and companies with which he is associated, has recently purchased the whole of the capital stock of the pulp mills of the Gulf Pulp & Paper Co. at Clarke City, in the Province of Quebec, on the St. Lawrence River, together with timber limits of about 625,000 acres. Under the arrangements for purchase, the Imperial Co. will acquire two-thirds of the capital, the other third being taken by outside interest.

The businesses of Edward Collins & Sons of Glasgow and Henry Leigh Slater of Manchester have been consolidated in the incorporation of the Amalgamated Paper Mills, Ltd., with a share capital of £900,000 issued at par, £400,000 of which is 8 per cent cumulative participating preferred shares.

The Kelvindale mills of Edward Collins & Sons are among the oldest paper-making concerns in the United Kingdom, having been established in 1746. The average output of the two concerns is 190 tons per week. Recently the Slater Co., in association with M. A. Berges of the Papeteries Berges (Paris), formed a new company, the Société Franco-Anglaise des Papiers Speciaux, which is erecting a new plant at Eragny, near Paris, for the purpose of coating the papers manufactured by the Berges Co.

The profits of the Collins and Slater firms combined advanced from £86,797 in 1916 to £220,219 in 1918, but dropped to £56,791 in 1919, due to war condtions. Profits for this year are estimated at the rate of £294,803 per annum.

Although only a few of the companies publish public reports, those of the following large companies will give some idea of the profits made in this industry.

PROFITS AFTER PROVIDING FOR EXCESS PROFIT DUTY

	1919	1918	1917
Edward Lloyd	£223,032	£117,940	£151,536
Ordinary dividend	13⅓%	11¼%	11¼%
Alex Pirie & Sons	£105,543	£102,500	£83,833
Ordinary dividend	6 %	%	6 %
C. Marsden & Sons	£97,930	£66,180	£26,884
Ordinary dividend	9 %	8½%	6 %
A. M. Peebles & Son	£43,287	£38,349	£21,102
Ordinary dividend	9 %	5 %	....
A. E. Reed & Co.	£135,485	£111,295	£73,308
Ordinary dividend	14%	10%	10%
Spier Brothers	£236,500	£155,584	£155,345
Ordinary dividend	14%	12½%	12½%

Protective Agreements

Compared with Germany, where there were several cartels, the British paper industry is almost without organization. Every individual firm moved along in its own way. It was only under stress of war that the British makers made price agreements among themselves. Fear of foreign competition has also caused a suggestion that a duty of 15 per cent be imposed on all imports to protect home industries.

Raw Materials

The shortage of raw material is gradually becoming less acute and more stock is coming in. In the first half of the current year (January to June) the import of pulp wood, grass, rags, etc., exceeded 600,000 gross tons, compared with the import of the corresponding period of 380,000 tons and a pre-war total of 563,758 tons. The net import of pulpwood, the chief raw material, for the last six months amounted to 505,195 tons, esparto, rags, etc., amounting to only 94,830 tons, with a total aggregate value of £14,403,831.

Foreign Trade

England is still importing from abroad immense quantities of manufactured paper of all kinds, the aggregate of the six months being 346,047 gross tons, as compared with 303,638 tons in the same period during 1913. Although the imports are large, England's exports of paper manufactured in the United Kingdom made a poor showing, the total for the six months period being only 48,489 gross tons. It is this extraordinary excess of imports of foreign-made paper over the comparatively small quantity of British exports that causes the paper manufacturers anxiety. Norway and Sweden furnished England with 45 per cent of its printing and writing paper during the last half year, and 75 per cent of packing and wrapping paper, including tissue paper.

The reappearance of Germany as an exporter of approximately 8,000 tons is an interesting item. Russia exported to Great Britain 13,110 tons of packing and wrapping paper. Imports of straw board amounted to 105,900 tons and came mostly from Holland. The United States supplied England with a little more than 2,000 tons.

Corn Products Refining Co. to Build Big Factory in Kansas City

Approximately $8,000,000 will be required for an extensive manufacturing enterprise to be established here by the Corn Products Refining Co., of Chicago, New York and other cities.

The amount will be expended for branch works manufacturing sirup and various other products from corn. Seventy-five acres of land have been bought for the site and engineers are preparing plans for buildings, the construction of which will begin in September. There will be seven large buildings, all of reinforced concrete construction, the largest to have about 100,000 sq.ft. of floor space.

The manufacturing machinery to be installed will consume each day about 25,000 bu. of corn and 10,000,000 gal. pure water from an artesian well. About 1,000 operatives will be employed, most of the machinery being automatic. Prominent officials of the corporation expect to profit considerably by the increasing use of the Missouri River for the transportation of freight. Large quantities of corn are imported from the Argentine Republic by the Corn Products Refining Co. and this supply may in time come up the Missouri River when this ship transportation for the lower Missouri has been assured.

Maritime Chemists Association Holds Annual Meeting

The annual meeting of the Maritime Chemists Association was held on Aug. 3 in St. John, N. B. The chief business of general interest transacted was the formation of a Maritime Section of the Society of Chemical Industry which will function as a separate section of the Society. The program also included among others an illustrated address by H. Jermaine Creighton, D. C. S., of Swarthmore College, Pa., in "How the Nitrogen Problem Has Been Solved," and an interesting paper by Prof. H. C. Hanbon on the newly discovered salt deposits at Malagash, N. S.

Officers elected for the ensuing year were:

President, Dr. H. S. Biglow, Mt. Allison University.

Vice-presidents, Dr. H. Jermaine Creighton, Swarthmore College; I. C. Mackie, Dominion Iron & Steel Co.

Executive, Prof. H. C. Hanlon, N. S. Agricultural College; A. F. Blake, Atlantic Sugar & Refining, Ltd.

Secretary and treasurer, H. B. Vickery, Provincial Normal College.

Lack of Coal a Menace to Paper Supply

President Dodge of International Paper Co. says the Commerce Commission must modify its priority orders in allocating coal and wood cars or many newspapers will have to suspend publication because production and shipment of print paper must cease. He says over 400 newspapers of United States, directly dependent on company for their stock, are now "living from hand to mouth."

Manganese in Southern Nevada

More than twenty-five manganese mines and prospects in the southwestern part of Nevada are described in Bulletin 710F of the U. S. Geological Survey. The average content of Mn is reported as about 40 per cent. The total estimated amount of Mn runs into many hundreds of thousands of tons. The limiting factors are found in transportation and cost of production.

Milk Plants in Washington

Utility plants costing approximately $600,000, capable of handling 500,000 lb. of milk daily, with an annual output of an estimated value of $8,000,000, are being constructed by United Dairy Associations of Washington in Seattle, Wash. These plants will manufacture the raw milk into butter, milk powder, ice cream and cheese.

One of the new plants to be constructed at Lynlen will cost $150,000 and will handle 100,000 lb. of milk daily. Skagit County dairymen are building a $250,000 plant at Burlington with a daily capacity of 250,000 lb. of milk. Snohomish County dairymen purchased a modern condenser plant.

Besides these projects the dairymen in Grays Harbor County have at Satsop what is said to be the largest cheese factory in this country, if not in the world. Its output is 3,000 lb. every day in the year.

Products of these plants will be standardized, so that large orders can be filled from products of all the plants.

Dyes or Dyestuffs?

A laboratory for research on dyestuffs and explosives has been established at George Washington University, Washington, D. C. It is to be under the general supervision of Prof. H. C. McNeil and in charge of G. W. Phillips, formerly of the C. W. S. Prof. C. E. Munroe of the National Research Council will be consulting chemist of the laboratory.

Why do they call dyes "dyestuffs"? Dyes is a good old English word that means exactly the same thing. We might as well say colorstuffs. We are glad to see the laboratory established, our only objection is to its German name. The word dyestuffs indicates bulk and weight rather than tinctorial power. Dyes is better.

Glass Works for Birmingham

General glass products in the nature of bottles will be manufactured in Birmingham, Ala., in a $400,000 plant to be built by the Birmingham Glass Manufacturing Co., a new enterprise organized by New York and Alabama capitalists, who have secured a site and land containing several million tons of silica sand. The officers named for the first year are Sol W. Quinn, president; H. C. Bryson, vice-president, both of New York, and E. R. Owen, secretary, of Birmingham, Ala.

Use of Glycol as a Substitute for Glycerol

It is proposed in *Der Seifenfabrikant* (vol. 40, pp. 245-6, 1920) by H. Wolff of Berlin that glycol be used in the place of glycerol as a substitute owing to its hygroscopic and viscous nature. It is used to advantage, he says, for printing inks, for softening, cleaning and felting textiles and in pharmacy. Schlinck & Co. has patented its use (Ger. Pat. 315,222) to neutralize the acidity of oils by boiling them with glycol under reflux in order to convert the free acids into glycol esters.

New Lignite Carbonization Research Plant in North Dakota

The sum of $200,000 has been subscribed by private persons to build and operate a research plant for the carbonization of lignite at New Salem, N. D. It will be conducted by the staff of the U. S. Bureau of Mines.

The Chemistry of Churning Butter

L. S. Palmer of the Missouri Agricultural Experiment Station has made a study of the chemistry of churning butter. As the stage of lactation advances the protein concentration of the milk increases, while the size of the fat globules decreases. Therefore the difficulty in churning increases, and this factor is beyond the complete control of the butter maker. His microscopic work gave strong support to Fischer's idea that the formation of butter consists in a change of fat-in-colloid-hydrate emulsion (cream) into a colloid-hydrate-in-fat emulsion, which is butter.

June Exports and Imports of Dyes and Dyestuffs

Countries	Aniline Dyes, Value	Logwood Extract, Value	All Other, Value
Belgium	$42,627	.....	.....
Denmark	.....	.....	$190
France	134,705	$64,508	43,183
Greece	2,787	.....	.....
Italy	40,803	24,943	17,826
Netherlands	378	33	16,866
Norway	1,710	.....	2,111
Portugal	4,235	.....	330
Spain	110,340	10,291	34,789
Sweden	4,078	.....	2,700
Switzerland	3,430	.....	13
Turkey in Europe	2,150	.....	230
England	128,353	19,584	138,878
Scotland	7,618	.....	8,955
British Honduras	.....	.....	22
Canada	188,731	23,036	101,528
Costa Rica	100	64	269
Guatemala	939	14	268
Honduras	.....	.....	159
Nicaragua	60	5	146
Panama	.....	.....	146
Mexico	4,229	.....	3,607
Newfoundland and Laborador	46	.....	761
Jamaica	.....	.....	25
Trinidad and Tobago	.....	30	.....
Cuba	1,792	12	7,754
Virgin Islands of U. S.	15	.....	.....
Dutch West Indies	3	.....	4
Haiti	.....	.....	24
Dominican Republic	45	.....	1,272
Argentina	38,893	.....	16,937
Bolivia	5,360	.....	203
Brazil	43,840	60	22,363
Chile	15,845	1,300	7,396
Colombia	3,700	106	4,298
Ecuador	408	454	.....
Peru	12,476	1,470	11,411
Uruguay	1,145	.....	.....
Venezuela	588	93	16
China	622,345	10,000	240,096
British India	199,036	.....	134,571
Straits Settlements	.....	.....	101
Dutch East Indies	.....	.....	99
French East Indies	19,690	.....	864
Hongkong	26,095	.....	22,127
Japan	680,215	66,157	371,011
Siam	2,463	.....	285
Turkey in Asia	.....	.....	7,012
Australia	23,128	314	11,881
New Zealand	7,023	.....	3,011
Philippine Islands	1,090	.....	1,160
British South Africa	6,678	.....	2,293
Egypt	323	.....	.....
Total	$2,389,515	$222,474	$1,239,191

IMPORTS

Countries From	Alizarin and Alizarin Dyes Lb.	Alizarin and Alizarin Dyes Value	Colors or Dyes Not Elsewhere Specified Lb.	Colors or Dyes Not Elsewhere Specified Value	Indigo, Natural Lb.	Indigo, Natural Value
Denmark	.....	.....	441	$1,297	.....	.....
France	.....	.....	2,702	3,991	21,116	$16,246
Germany	.....	.....	76,848	85,293	10	32
Netherlands	.....	.....	3,502	2,835	.....	.....
Switzerland	.....	.....	144,211	256,674	.....	.....
England	1,177	$961	6,413	7,015	766	750
British India	.....	.....	.....	.....	2,850	7,392
Japan	.....	.....	30	10	.....	.....
Total	1,177	$961	234,147	$357,115	24,742	$24,420

Countries From	Indigo, Synthetic Lb.	Indigo, Synthetic Value	Extracts and Decoctions for Dyeing Lb.	Extracts and Decoctions for Dyeing Value
France	12,813	$8,103	13,544	$2,417
Spain	.....	.....	12	15
England	.....	.....	13,071	2,117
Scotland	.....	.....	5,015	1,295
Jamaica	.....	.....	20,930	7,116
Haiti	.....	.....	104,447	5,073
Japan	.....	.....	875	77
Total	12,813	$8,103	157,894	$18,110

Payne Hears War Mineral Plea

After listening to arguments of representatives of the Mining Congress and attorneys for claimants under the war minerals relief act, the Secretary of the Interior has stated that he has no objection to the enactment by Congress of a law giving to these claimants the right to appeal their cases to the United States Court of Appeals.

Manufacture of Paper Pulp in Congo

Papyrus, which grows in great abundance near Elizabethville, in the Belgian Congo, principally along the lower Lualaba, near the lakes of Kabuli, Sjemba, Kisali and Neaga, is to be exploited by a large company which has been granted a concession. It is planned to establish near the river a large plant, costing two and a half million francs, which will have an initial production of 20,000 tons of pulp. The material for this factory is to be sought among Belgian and, if necessary, allied manufacturers.

The papyrus of the Congo has proved on analysis to contain 37.8 per cent cellulose. After research and experiments, a process was discovered for bleaching the plants which had been vainly sought for fifty years.

June Imports of Tin Bars, Blocks or Pigs, Grain or Granulated

Customs Districts	Lb.	Value
Massachusetts	167,888	$97,702
New York	8,880,892	5,420,336
Philadelphia	56,071	28,683
Pittsburgh	56,000	43,600
Maryland	168,047	109,200
San Francisco	1,309,785	863,553
Washington	313,568	186,915
Michigan	280,074	163,582
Total	11,232,325	$6,913,571
Countries from:		
Netherlands	1,114,271	$617,813
England	4,085,504	2,271,448
Canada	33,494	52,590
Costa Rica	33,429	17,589
China	392,216	223,198
British India	65,100	27,000
Straits Settlements	4,404,278	3,078,764
Hongkong	829,556	482,598
Australia	274,477	162,571
Total	11,232,325	$6,913,571

Tin in Ore	Tons	Value
Total	2,994	$2,239,266

Personal

Dr. JOHN J. ABEL, professor of pharmacology at the Johns Hopkins Medical School, Baltimore, Md., has received an honorary doctorate of laws from Cambridge University. Dr. Abel's numerous and distinguished researches on the chemistry of animal tissues and fluids and on the physiological and therapeutic action of various substances render him worthy of academic distinction.

Dr. H. K. BENSON, in charge of the chemistry department of the University of Washington, is spending the summer at Lake Bunsen, B. C., conducting special research work for the American Nitrogen Products Co. Dr. Benson will return to Seattle in September.

A. W. FAHRENWALD has been appointed ore-dressing engineer with the U. S. Bureau of Mines in charge of the station at Moscow, Idaho.

CHARLES H. FULTON, formerly professor of metallurgy in the Case School of Applied Science, has been appointed

director of the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., and not head of the Mining Department as given erroneously in our issue of Aug. 4. Prof. Forbes is head of the Mining Department.

H. S. GALE, who for many years has been the Geological Survey's specialist on potash and nitrate, has resigned to enter private employment.

RALPH A. GOULD and BRYANT S. DRAKE announce their association, from Aug. 1, as a partnership under the firm name of Gould & Drake, chemical engineers, with offices at 216 Pine St., San Francisco, Cal.

CHARLES S. HOWARD, formerly an instructor in the department of electrical engineering and physics at the U. S. Naval Academy, has accepted a position as junior chemist in the Quality of Water Division of the Water Resources Branch of the U. S. Geological Survey, Washington, D. C.

ERIC A. LOF has just returned from Europe, where he visited a large number of industrial plants in Sweden, Norway, England, France and Belgium.

Dr. VAN H. MANNING, director of research of the American Petroleum Institute, has returned from a trip to Europe.

E. P. MATHEWSON has gone to Arizona on a professional engagement.

PAUL MOORE, at present director of the Information Bureau of the War Trade Board, will become the secretary of the Division of Research Extension, National Research Council, on or about Oct. 1. Mr. Moore will devote himself to the promotion of research with particular reference to the industries. In this work he will be associated with Dr. H. E. Howe, who continues actively in this field as the chairman of this division of the Council.

Prof. ARTHUR M. PARDEE has resigned from the chair of chemistry at Washington and Jefferson College, Washington, Pa., to become the head of the department and professor of chemistry at the University of South Dakota, Vermilion, S. D.

Dr. CHARLES L. PARSONS, secretary of the American Chemical Society, has returned to Washington following the adjournment of the International Union of Pure and Applied Chemistry at Rome, where he acted as the American representative.

JOHN H. RAMAGE, formerly metallurgist, industrial department, U. S. Navy Yard, Norfolk, Va., is now metallurgist for the Westinghouse Lamp Co., Bloomfield, N. J.

RICHARD R. REES has resigned as chief metallurgist at U. S. Arsenal, Watervliet, N. Y., to accept a position as metallurgist with the Neptune Meter Co., Long Island City, N. Y.

R. T. READ, of the safety department of E. I. du Pont de Nemours & Co., has been appointed by the National Safety Council as permanent secretary of the Delaware local council.

J. C. TOWNSEND, foremerly safety engineer for the International Shoe Co., of St. Louis, has been appointed by the National Safety Council manager of the Grand Rapids division.

Obituary

Dr. E. Y. TITUS, a member of the technical staff of the International Coal Products Co., Newark, N. J., died on Aug. 7, as a result of blood poisoning following an accident in which he was run down by an automobile. Dr. Titus was formerly associate professor of physical chemistry at the University of Wisconsin; later chief chemist at U. S. Nitrate Plant No. 1, Muscle Shoals, Ala., and prior to his engagement with the International Coal Products Co. he was in the U. S. Fixed Nitrogen Research Laboratory. He had been married about a month at the time of his death.

Book Reviews

IRON AND STEEL. By *Erik Oberg* and *Franklin D. Jones*, editor and associate editor of *Machinery*, in collaboration with prominent metallurgists and steel-makers. 328 pp. New York: The Industrial Press.

In the rather limited space of 300 pages of pica type, the authors present "A Treatise on the Smelting, Refining, and Mechanical Processes of the Iron and Steel Industry, Including the Chemical and Physical Characteristics of Wrought Iron, Carbon, High-Speed and Alloy Steels, Cast Iron, and Steel Castings, and the Application of These Materials in Machine and Tool Construction." Obviously the words "brief outline" would be better than "treatise." Thus in the very sub-title the authors exhibit that defect of non-precise diction which will blast their hopes that their volume will find favor as a text-book for technical students. The casual reader may not mind, but the budding engineer or technician should not be told that "wrought iron" and "bushelled scrap" are the same thing (p. 72) nor think of "ingot iron" and "wrought iron" as the same type of material (p. 79).

It is too bad that the prominent metallurgists collaborating in this work did not revise the chemical terminology. When discussing bessemer steel (p. 139) it is said that "the graphitic carbon is burned into the combined form," whatever that action may consist in. Also on page 140 the statement is made that "manganese . . . burns the sulphur (which is in the form of iron sulphide) into managanese sulphide." At the bottom of page 147 is a simple explanation of rephosphorization in acid steel which will attract those metallurgists who are delving into the mysteries of balanced reactions for light.

Had the authors confined themselves to the mechanical processes involved in the manufacture of steel products, a happier result would undoubtedly have been attained. Their chapter on Rolling and Drawing contains an unusually full and well-illustrated account of the operations involved in the cold drawing and rolling of shafting, strip and wire. Forty pages are devoted to this matter, a disproportionate amount in a general survey, but fortunately so in this case. Doubtless by experience and intimate contact the authors could have presented an authoritative yet concise account of non-metallurgical operations in modern steel mills which have filled a vacant spot in American technical literature, rather than merely another book, of which there are already far too many. E. E. THUM.

Current Market Reports

The Iron and Steel Market

Pittsburgh, August 20, 1920.

The iron and steel market has not established any general or definite trend, but rather is displaying even more confusing features than a few weeks ago. For instance, semi-finished steel prices are showing a distinct downward trend and pig iron is not merely showing an advancing tendency, it actually has advanced, and in the case of valley foundry iron by no less than $4 a ton in a week. The influence of improving transportation conditions is not defined. There does not seem to be any increased consumptive demand for steel in consequence, while there are heavier deliveries of steel, yet this does not seem to make steel more plentiful.

IMPROVED TRANSPORTATION

The improvement in transportation, as regards the movement of steel products, has been continuous for several weeks. Taking the steel industry as a whole, the rate of

accumulating of steel began to decrease several weeks ago, while the increase in shipments has proceeded far enough so that no more steel is accumulating, the present situation being that while some mills have added to their accumulations in the past week or two others have moved some of the steel accumulated many weeks ago.

Hopes had been entertained that the Interstate Commerce Commission would allow the coal-car preference order to expire Aug. 19, at the end of its two 30-day periods, thus releasing many flat-bottom gondolas from coal movement to pig iron and steel movement, but the commission has extended the order for another thirty days, to Sept. 18, and has not relaxed the provision that gondolas 38 in. and higher inside measurement are to be considered coal cars. Apart from this, the Pennsylvania system has made an order on its own account that cars classifiable as coal cars may no longer be loaded with other freight when destined to travel toward the coal mine, and thus shipments of some valley producers to the Pittsburgh district are impeded. On the whole, however, car supplies at furnaces and mills are increased by reason of there being a more rapid movement of cars all around, the total quantity of transportation having increased. The point has not yet been reached at which coal mines are able to load all the cars furnished, but that time may come soon, and then some cars would automatically be released for use by the iron and steel and other industries.

A noteworthy improvement in transportation is seen in connection with placement of cars for coke loading in the Connellsville region. For several months the production there has been regulated by the car supply. The Connellsville *Courier* reports production of coke in the Connellsville and lower Connellsville region in the past three weeks as having been as follows, successively: 172,870 tons, 194,140 tons, 219,440 tons. A labor shortage has not yet been uncovered in the region, although a continuation of increasing car supplies would eventually make labor the limiting factor. The better car placements are due solely or chiefly to quicker movement of the cars that have been in the coke service right along. The quantity of coke en route to furnaces has been reduced, and thus the receipts have increased even more than the shipments.

Advancing Pig Iron

The advances in pig iron are rather a curious phenomenon, considering the fact that any trend observable in steel products is downward, while pig iron was already too high relative to steel prices. The buying of pig iron is not heavy, but it is so insistent that when furnaces ask higher prices enough consumers pay the advance to establish the market at the higher figures. In the past week sales have established foundry pig iron, valley furnaces, at a $4 advance, while transactions in steel-making grades have scarcely been sufficient, with conservative market reporting, to establish higher levels distinctly. In foundry iron the transactions, though totaling only a few thousand tons, have established $50 valley as the market, a few of the sales being for delivery to the end of the year. Former quotations were: bessemer, $47; basic, $46.50; foundry, $46. If foundry iron does not recede from $50 it is quite probable that within a few days the other grades will be clearly established at a $50 level. As the market has never before advanced even by a dollar or two on such light transactions, there are naturally misgivings in some quarters as to what the end of this curious movement will be.

Semi-Finished Steel

It is learned that in a number of recent transactions in sheet bars $70 Pittsburgh was shaded slightly, and this figure represents absolutely the top of the market, though three weeks ago the market seemed clearly established at $75 as minimum. There are reports of a number of transactions in standard billets, particularly in the East, on the basis of $60 Pittsburgh. Obviously $50 pig iron and $60 billets are not properly aligned. Again, however, bars and shapes can be bought for forward delivery at about 3c., or $60 a net ton, and this does not agree with $60 per gross ton for billets.

Many statements are now being made that the decline in automobile building is not as great as has been reported in some quarters, and it seems evident that there is a good bit to explain away, if possible. The steel industry feels much less pressure from the majority of automobile factories for steel deliveries, but the loss in tonnage is a small item compared with the total steel productive capacity, since at capacity for both industries the automobile industry would not absorb more than 6 or 7 per cent at the outside of all the steel. In such items as hot and cold rolled strips, however, the decrease in demand is important.

As to railroad buying, it is quite improbable that there will be any buying of cars and locomotives to amount to anything for delivery before early next year. Car and locomotive repair work will continue and will absorb considerable tonnages of steel. A little interest is beginning to be shown in rails for next year.

In steel for large construction jobs there is very little demand and it does not look as though there would be much activity along this line until some changes occur in fundamental conditions.

The general demand for steel, for a wide variety of uses, continues good and it remains the marvel of the trade that so much steel can be absorbed when there do not appear to be heavy consumptive operations in progress.

The Chemical and Allied Industrial Markets

New York, August 20, 1920.

Considering the season of the year, there has been considerable price activity during the week. The movement in general has been upward, with a noticeably firmer undertone to the market, although the volume of business transacted does not seem to be very much more than the usual amount. The increases, where they have occurred, have been made by producers who are finding it impossible to meet existing prices with the increased labor costs and transportation difficulties.

Among the items that came up is *calcium chloride*, fused lump, formerly listed at $25@$30 per ton as low price and now difficult to obtain under $33. With it the *granulated* grade also advanced to a low mark of 2@2½c. per lb. The average price for *formaldehyde* is between 40@50c. per lb., although it is possible to get small lots of from one to five tons at a figure slightly under the market, from second hands who are finding it difficult to find purchasers at 40c.

The newly arranged schedule of prices on *sal soda* issued by producers ranges between $2@$2.25 per cwt.; this represents an increase of 75c. per cwt. and is evidently due to the increased cost of production and is also a move in preparation for the coming buying season. In comparison with the rise of *sal soda* is the sharp decrease of *caustic soda*, which is down as low as $5.60, against recent quotations of $6.25@$7 per cwt. There is no doubt the demand for this item has greatly fallen off and with the banks calling in notes holders are making concessions to get rid of the material on hand.

Coal-Tar Products

The absence of buying interests is felt in the coal-tar products market and prices are at about the same levels as previously reported. Both *aniline oil* and *salts* have fallen off, the former being listed at 30@33c. and the latter at 35@40c. per lb., with very little activity displayed. *Benzidine sulphate* has also been affected and current quotations are 85@90c., against the recent 90c.@$1 per lb. level. In contrast with these comparatively small drops, *dimethylaniline* came down from $1.35@$1.45 to $1@$1.05 per lb. The looked-for increased interest caused by the expected return of textile mills to their former activity has not strengthened this market to any extent and whereas the drops are not numerous there is not one actual increase in the list.

Ortho-toluidine and *paranitraniline* are both slightly under last week's listing, the former being quoted at 30@35c. and the latter $1.10@$1.20 per lb., representing a drop of 25c. per lb. for this material.

In line with the other allied markets the *waxes* continue weak, as demand is practically at a standstill. Through a mistake in the price table of the Aug. 18 issue, *Carnauba*, No. 2, regular, was quoted at 55@60c. per lb., whereas the correct price is 85@86c., a 5c. difference between that and No. 1, which is now being sold around 90@95c. per lb. *Montan*, crude, is weaker at 25@26c. than it was last week and business has been very dull as a result.

Vegetable Oils

	Today	Week Ago	Month Ago	Year Ago
Cottonseed oil, crude	$0.10	$0.10@.11	$.015½	$0.22
Cottonseed oil, summer yellow	.12½	.13½@.13½	.18½	.27
Cottonseed oil, winter yellow	.17½	.19	.21	.27

The above table shows the decline in cottonseed oil during the past year. The principal reason back of this downward movement is the persistent lack of demand on the part of consumers, with a resulting accumulation of supplies in the hands of the crushers. To remedy this situation the farmer is being urged to withhold his supply of seed, thereby causing a scarcity on the market of this commodity and boosting the price back to former war levels. The present price is the lowest it has ever been since this commodity had its first sensational rise immediately after being introduced on the market, when the crude could be obtained for 5@6c. per lb. Previously it had been thrown away as useless until the discovery was made that it could be used in cattle feeding and as a fertilizer. During the war the peak was reached when it sold as high as 24c. per lb., but since then owing to slackening of demand the price has been steadily falling off.

Miscellaneous Materials

Feldspar remains very scarce and $17@$20 is the nominal quotation, although all contracts are being written with a provisional clause making the price subject to "prevailing quotation at time of shipment." All grades of *shellac* have strengthened and although it is possible to obtain small quantities of this material slightly under the current quotations, it would be only the cheaper grades on which concessions would be granted. The fall crop, while there is no surplus, promises to meet requirements, and with the present heavy inquiry it is expected these prices will prevail for some time.

The St. Louis Market

St. Louis, Mo., August 17, 1920.

The chemical market for this district continues quiet and prices remain firm. With the settlement of the railroad rates and wages many large buyers are coming into the market for future needs and producers are booking orders for 1921 delivery. An increase in prices for nearly all lines is predicted in the near future, as the increase in freight rates will in many cases materially affect the cost of raw materials.

The local supply of chemicals is now normal and ample to meet present demands, with the following quotations, based on car lots unless otherwise noted, holding firm. The market for *sulphuric acid* continues good with prices unchanged. The 60 deg. grade is quoted at $16 per ton and 66 deg. at $24 per ton. *Oleum* remains unchanged at $27.50 per ton.

Muriatic acid is quiet and prices unchanged at $25 per ton and 2@2¼c. per lb. in carboys.

The supply of *sodium bisulphate* is now ample and prices are quoted at from $5 to $6 per ton, a slight reduction from previous quotations.

Nitric acid remains unchanged and is quoted at $7 per cwt. for the 36 deg. and $10 per cwt. for the 42 deg. *Standard mixed acid*, consisting of 36 deg. nitric and 61 deg. sulphuric, is unchanged at 11½c. per lb. of nitric and 1½c. per lb. of sulphuric acid.

Zinc chloride, 50 per cent solution, is quoted at $4 per cwt., an increase of 25c. due to rise in cost of raw material.

Phenol is plentiful due to a local firm disposing of surplus Government stocks, and prices are unchanged at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 – 16.00	16.25 –
Boric, crystals	lb.	.15½ – .16	.16½ – .19
Boric, powder	lb.	.15½ – .16½	.17 – .20
Citric	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal)	cwt.	2.00 – 3.00	3.10 – 4.00
Hydrofluoric, 52 per cent	lb.	.13½ – .14	.14½ – .15½
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	.60 – .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.[illegible] – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	16.00 – 17.00	18.00 – 20.00
Sulphuric, 66 deg., drums	ton	26.00 – 28.00	
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P.	lb.	1.45 – 1.50	1.55 – 1.65
Tannic (tech)	lb.	.60 – .70	.80 – .90
Tartaric, crystals	lb.		.74 – .77
Tungstic, per lb. of WO	lb.		1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl, 95%	gal.		3.25 – 3.30
Alcohol, Methyl, pure	gal.		3.50 – 3.55
Alcohol, denatured, 188 proof (nominal)	gal.		1.10 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.		1.05 – 1.10
Alum, ammonia lump	lb.	.05 – .05½	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.17	.18 – .19
Aluminum sulphate, commercial	lb.	.04½	
Aluminum sulphate, iron free	lb.	.06 –	
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ – .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.34 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.13½ – .14½
Ammonium nitrate	lb.	.09 – .10	.11 – .14
Ammonium sulphate	lb.	.07 – .07½	.08½ –
Amylacetate	gal.		5.00 –
Amylacetate tech.	gal.		4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ – .16	.16½ – .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 – .21	.22 – .25
Barium chloride	ton	150.00–160.00	
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .12	.12½ – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Brimstone (see sulphur, roll)			
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	
Calcium carbide	lb.	.04½ .04½	.04½ – .05½
Calcium chloride, fused, lump	ton	33.00 – 34.00	35.00 – 45.00
Calcium chloride, granulated	lb.	.02 – .02½	.03 – .03½
Calcium hypochlorite (bleaching powder)	cwt.	6.50 – 7.50	8.00 – 8.50
Calcium peroxide	lb.		1.50 – 1.70
Calcium phosphate, monobasic	lb.		.75 – .80
Calcium sulphate, pure	lb.		.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)	lb.		.80 – 1.05
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.40 – .43	.44 – .47
Cobalt oxide	lb.		2.00 – 2.05
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.		.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.	1.10 – 1.30	1.40 –
Ethy Acetate pure (acetic ether 98% to 100%)			1.75 –
Formaldehyde, 40 per cent (nominal)	lb.	.40 – .45	.48 – .50
Fusel oil, ref.	gal.		5.25 – 6.00
Fusel oil, crude (nominal)	gal.		
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra	lb.		.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.		.03 – .20
Iron sulphate (copperas)	cwt.		2.75 – 3.00
Lead acetate, normal	lb.		.13½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.		.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.		1.50 –
Magnesium carbonate, technical	lb.	.12½ – .13½	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 3.90	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.		3.50 – 3.60
Nickel salt, double	lb.		.14 – .16
Nickel salt, single	lb.		.13 – .14
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.		.35 – .37
Potassium bichromate	lb.	.36 – .38	.39 – .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0 52 – $0 56	$0.57 – $0 58
Potassium bromide, granular	lb.	–	.70 – .73
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.20 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.16 – .17½	.18 – .20
Potassium hydroxide (caustic potash)	lb.	.27 – .28	.29 – .33
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.17 – .17½	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 – .....
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .40
Potassium sulphate (powdered)	ton	$225.00 – 240.00	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	40.00 – 50.00
Silver cyanide (nominal)	oz.	..... –	1.25 – .....
Silver nitrate (nominal)	oz.	..... –	.60 – .62
Soda ash, light	100 lb.	..... –	3.20 – 3.50
Soda ash, dense	100 lb.	..... –	3.55 – 3.65
Sodium acetate	lb.	.10 – .15	.20 – .25
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.50
Sodium bichromate	lb.	.22 – .24	.26 – .27
Sodium bisulphate (nitre cake)	ton	7.00 – 8.00	9.00 – 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½ –	.10 – .11
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.10	2.15 – 2.25
Sodium chlorate	lb.	.11 – .12	.12½ – .14
Sodium cyanide, 96-98 per cent	lb.	.25 – .30	.32 – .35
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	5.60 – 5.70	5.75 – 6.00
Sodium hyposulphite	lb.	..... –	.03 .04
Sodium molybdate	lb.	2.50 –	3.25½ – .....
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodium sulphide, crystal, 60–62 per cent (conc)	lb.	.09½ – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.04 – 0.4½	.04½ – .05
Strontium nitrate, powdered	lb.	.15 – .18½	.19 – .20
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	..... –	3.80 – 4.35
Sulphur, roll (brimstone)	100 lb.	..... –	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½ – .44	.45 – .46
Tin oxide	lb.	..... –	.55 – .65
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 – .13½	.13½ – .17
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.11 – .12	.12 – .13
Zinc oxide, U. S. P.	lb.	.17 – .25	..... – .....
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40	—	$1.50
Alpha naphthol, refined	lb.	1.60	—	1.70
Alpha naphthylamine	lb.	.50	—	.52
Aniline oil, drums extra	lb.	.30	—	.33
Aniline salts	lb.	.35	—	.40
Anthracine, 80% in drums (100 lb)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10
Benzidine, base	lb.	1.35	—	1.40
Benzidine, sulphate	lb.	1.15	—	1.25
Benzoic acid, U.S.P.	lb.	.85	—	.90
Benzoate of soda, U.S.P.	lb.	.80	—	.90
Benzol, pure, water-white, in drums (100 gal)	gal.	.38	—	.40½
Benzol, 90%, in drums (100 gal)	gal.	.36½	—	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate (nominal)	lb.	3.50	—	4.00
Beta naphthol, sublimed (nominal)	lb.	.....	—	.....
Beta naphthol, tech (nominal)	lb.	.85	—	.95
Beta naphthylamine, sublimed	lb.	2.25	—	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.05	—	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00	—	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65	—	.75
Dichlorbenzol	lb.	.08	—	.10
Diethylaniline	lb.	1.50	—	1.60
Dimethylaniline	lb.	1.00	—	1.05
Dinitrobenzol	lb.	.30	—	.37
Dinitroclorbenzol	lb.	.32	—	.35
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.40	—	.45
Dinitrotoluol	lb.	.....	—	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.40
Diphenylamine (nominal)	lb.	.80	—	.85
H-acid (nominal)	lb.	2.00	—	2.25
Metaphenylenediamine	lb.	1.25	—	1.30
Monochlorbenzol	lb.	.18	—	.20
Monoethylaniline	lb.	2.00	—	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.....	—	.....
Naphthaline, flake	lb.	.....	—	.19
Naphthaline, balls	lb.	.....	—	.19
Naphthionic acid, crude	lb.	.75	—	.85
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.50
Nitro-toluol	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	.85
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.30	—	.35
Para-amidophenol, base	lb.	2.50	—	3.00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlor-benzol	lb.	.08	—	.12
Paranitraniline	lb.	1.10	—	1.20
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	2.65
Paratoluidine	lb.	2.00	—	2.25
Phthalic anhydride	lb.	.60	—	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridin	gal.	2.00	—	3.50
Resorcin, technical	lb.	4.25	—	4.50
Resorcin, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	—	.52
Salicylic acid, U. S. P.	lb.	.50	—	.60
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	—	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.35	—	.....
Toluol, in drums	gal.	.38½	—	.40½
Xylidine, drums, 100 gal.	lb.	.50	—	.65
Xylol, pure, in drums	gal.	.47½	—	.50½
Xylol, pure, in tank cars	gal.	.45	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.32½	—	.35½
Xylol, commercial, in tank cars	gal.	.30	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.37	—	.38
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	.90	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.86
Carnauba, No. 3, North Country	lb.	.35	—	.36
Japan	lb.	.17	—	.18
Montan, crude	lb.	.25	—	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¼	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 125 m.p.	lb.	.12½	—	.....
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	—	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	—	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	—	.18½
Stearic acid, single pressed	lb.	.20	—	.21
Stearic acid, double pressed	lb.	.22	—	.23
Stearic acid, triple pressed	lb.	.24	—	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.946	gal.	$2.15
Pine oil, pure, dest. dist.	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$14 00	—	$16.25
Rosin E-I	280 lb.	16.60	—	16.75
Rosin K-N	280 lb.	17.00	—	17.20
Rosin W. G.-W. W.	280 lb.	17.25	—	17.50
Wood rosin, bbl.	280 lb.	15.00	—	.....
Spirits of turpentine	gal.	1.60	—	.....
Wood turpentine, steam dist.	gal.	.....	—	.....
Wood turpentine, dest. dist.	gal.	.....	—	.....
Pine tar pitch, bbl.	200 lb.	.....	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.72	—	.....
Rosin oil, second run	gal.	.75	—	.....
Rosin oil, third run	gal.	.92	—	.....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.32½	—	$0.34
Upriver coarse	lb.	.20½	—	.22
Upriver caucho ball	lb.	.21	—	.21½
Plantation—First latex crepe	lb.	.33	—	.....
Ribbed smoked sheets	lb.	.29¼	—	.....
Brown crepe, thin, clean	lb.	.27	—	.....
Amber crepe No. 1	lb.	.29	—	.....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	—	$0.18
Castor oil, AA, in bbls.	lb.	.19	—	.....
China wood oil, in bbls.	lb.	.17½	—	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15	—	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.16½	—	.17
Corn oil, crude, in bbls.	lb.	.14½	—	.15
Cottonseed oil, crude (f.o.b. mill)	lb.	.10	—	.11
Cottonseed oil, summer yellow	lb.	.12½	—	.13
Cotonseed oil, winter yellow	lb.	.17½	—	.18
Linsed oil, raw, car lots (domestic)	gal.	1.50	—	.....
Linseed oil, raw, tank cars (domestic)	gal.	1.40	—	.....
Linseed oil, boiled, car lots (domestic)	gal.	1.56	—	.....

Olive oil, commercial	gal.	3.00 —	3.10
Palm, Lagos	lb.	.10½ —	.....
Palm, bright red	lb.	.10½ —	.....
Palm, Niger	lb.	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½ —	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.40 —	1.50
Rapeseed oil, blown, in bbls	gal.	1.60 —	1.70
Soya bean oil (Manchurian), in bbls N. Y.	lb.	.14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ —	.11
FISH			
Winter pressed Menhaden	gal.	$0.90 —	$1.05
Yellow bleached Menhaden	gal.	0.95 —	1.05
White bleached Menhaden	gal.	1.00 —	1.25
Blown Menhaden	gal.	1.00 —	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 —	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 —	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00 —	.....
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, min. 96% ba., Missouri	net ton	11.00 —	11.25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60.00 —	80.00
Casein	lb.	.15 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00 —	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50 —	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	20.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00 —	.....
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	.....
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	..... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	..... —	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	..... —	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	..... —	.10
Graphite, crucible, 85% carbon	lb.	..... —	.08
Graphite, crucible, 88% carbon	lb.	..... —	.09½
Graphite, crucible, 90% carbon	lb.	..... —	.10½
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.06 —	.....
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1¼@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	1.35 —	1.40
Shellac, orange superfine	lb.	1.40 —	1.45
Shellac, A. C. garnet	lb.	1.10 —	1.15
Shellac, T. N.	lb.	1.15 —	1.20
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	10.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	9.00 —	15.00
Talc, rubber grades, f.o.b. Vermont	ton	10.00 —	15.00
Talc, powdered, Southern, f.o.b. cars	ton	20.00 —	25.00
Talc, imported	ton	60.00 —	70.00
Talc, California Talcum Powder grade	ton	20.00 —	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90- 100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90- 95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50- 55
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45- ...
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75- ...
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45- 55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100 110
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90- 100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55- ...
Silica brick, f.o.b. Birmingham	1,000	51- 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	55- 60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18 —	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20 —	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	200.00 —	225.00
Ferro-manganese, 76-80% Mn, English	gross ton	195.00 —	240.00
Spiegeleisen, 18-22% Mn	gross ton	75.00 —	.....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.75 —	2.75
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77 —	.85
*Coke, foundry, f.o.b. ovens	net ton	20.00 —	.....
*Coke, furnace, f.o.b. ovens	net ton	18.00 —	20.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	.....
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00 —	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	0½ —	.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.70 —	.80
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.75 —	.85
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ —	.....
Pyrites, Spanish, run of mines, ci..f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.00 —	7.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	.....
Zircon, washed, iron free	lb.	.10 —	.....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	7.50
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	9.50
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8.15
Zinc, spot, E. St. Louis	7.90@8.40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	110.00@115.00
Iridium	oz.	350.00
Palladium	oz.	100.00@110.00
Mercury	75 lb.	88.00@90.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp.	14.50@15.00
Copper, heavy and wire	15.25@15.75
Copper, light and bottoms	13.00
Copper, heavy cut and crucible	16.25
Brass, heavy	9.50@10.00
Brass, light	7.25@7.75
No. 1 clean brass turnings	9.00@9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@5.00
Lead, heavy	7.25@7.50
Zinc, scrap	5.25

Structural Material

The following base prices per .00 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3.97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.47	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.47	4.12	3.37	.....	3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25	.....	.....	.....
Plates, ¼ to 1 in. thick	4.67	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SAN FRANCISCO—The Amer. Can Co., 120 B'way, New York City, is having plans prepared for the construction of a factory. Estimated cost about $500,000.

Connecticut

MONTVILLE—Robert Gair & Co., 50 Washington St., Brooklyn, N. Y., has awarded the contract for the construction of a 2-story, 200x500-ft. manufacturing building and power house to the Austin Co., 217 B'way, New York City. Estimated cost, $600,000. Noted June 30.

NEW HAVEN—Della Valle & Vece, archts., Exchange Bldg., will soon award the contract for the construction of a 2-story, 50x70-ft. factory on Olive St. for the Tuttle Color Printing Co., 30 Crown St. Estimated cost, $20,000.

STAMFORD — The Petroleum Heat & Power Co., Selleck St., is building a 1-story foundry. Estimated cost, $15,000. A. W. Steele, mgr. Noted July 28.

District of Columbia

WASHINGTON—The Vasil Steam Systems Co., 314-318 Washington Loan & Trust Bldg., plans to build a foundry and machine shop.

Illinois

DE KALB—Arthur Foster, archt., 155 N. Clark St., will soon receive bids for the construction of a 3-story, 40x179-ft. hospital for the Rev. J. A. Solon. A chemical laboratory will probably be installed. Estimated cost, $150,000.

EAST ST. LOUIS—Darling & Co., 4201 South Ashland Ave., Chicago, has awarded the contract for the construction of a fertilizer plant, including a 1-story, 50x80-ft. acidulation plant, to the Austin Co., 208 South La Salle St. Chemical equipment will be installed in same. Estimated cost, $500,000.

EAST ST. LOUIS—The Excelsior Tool & Machine Co., 32d St. and Ridge Ave., has awarded the contract for the construction of a 1-story foundry addition to the Stupp Bros. Bridge & Iron Co., Frisco Bldg. Estimated cost, $35,000.

HILLSBORO — The Bd. of Educ. has awarded the contract for the construction of a 2-story, 150x150-ft. high school to Jesse Gedney, Arcade Bldg., St. Louis, Mo. A physical and chemical laboratory will be installed. Estimated cost, $201,214.

MELROSE PARK — The Heppes Nelson Roofing Co., 4500 Filmore St., has awarded the contract for the construction of a roofing manufacturing plant including a 1-story, 80x140-ft. still and gas building, etc., to the Austin Co., 208 South La Salle St., Chicago. Estimated cost, $400,000.

Indiana

HAMMOND — The Metals Refining Co., Inc., Edison Bldg., Chicago, plans to build a lead smelting plant. W. Schoenbach, vice-pres.

SOUTH BEND—The George Cutter Wks. of the Westinghouse Electric & Mfg. Co. plans to build a 64x112-ft. foundry.

Kansas

ELDORADO — The City Comn. voted $25,000 bonds to install a new filter system at the city water plant.

PITTSBURGH—The Pittsburgh Builders' and Pavers' Brick Co. is having plans prepared for the construction of a brick plant to include four new kilns. Estimated cost, $60,000.

Louisiana

NEW ORLEANS — The Union Paper Products Co., 109 Tchoupitoulas St., has awarded the contract for the construction of a 1-story factory to Jos. Fromberz, 302 Title Guarantee Bldg. Estimated cost, $112,743.

Maryland

BALTIMORE—The Bd. of Awards, c/o City Register, will soon award the contract for the construction of a sludge digestion tank, pipe lines, etc., at the sewage disposal works on the shore of the Back River here. A. E. Christholf, Highways Engr.

Massachusetts

CAMBRIDGE—The Suffolk Engraving & Electrotyping Co., 394 Atlantic Ave., Boston, has awarded the contract for the construction of a 6-story, 100 x 100-ft. manufacturing building on Main St. to the Simpson Bros. Corp., 166 Devonshire St., Boston. Estimated cost, $225,000.

GREENFIELD — The School Bd. will soon receive bids for the construction of a 3-story high school at Federal and Sanderson Sts. A chemical laboratory will be installed in same. Estimated cost, $400,000. Patton & Blair, 579 5th Ave., New York City, archts.

Missouri

ST. LOUIS—The G. J. Fritz Fdry. & Machine Co., 20185 3d St., has awarded the contract for the construction of a 1-story foundry addition to the Stupp Bros. Bridge & Iron Co., Frisco Bldg. Estimated cost, $40,000.

New Jersey

NEWARK — The Amer. Can Co., 120 B'way, New York City, is having plans prepared for the construction of a factory. Estimated cost, about $500,000.

North Dakota

MARMARTH—The Bd. Educ. will receive bids until Sept. 7 for the construction of a 2-story, 61x91-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000.

Pennsylvania

ALLENTOWN—The Allen Tire & Rubber Co., 510 Hamilton St., has awarded the contract for the construction of a 2-story rubber factory to the Allentown Constr. Co., 5th and Hamilton Sts. Estimated cost, $2,500,000.

CHESTER — Allison & Co., Law Bldg., has awarded the contract for the construction of a 1-story, 30x65-ft. paint shop and dipping tank to the John R. Wiggins Co., Inc., Otis Bldg., Philadelphia.

COALDALE — The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. John T. Simpson, Essex Bldg., Newark, N. J., archt.

NEW CASTLE—The Johnson Bronze Co., South Mill St., has awarded the contract for the construction of a foundry, etc., to the Moore-Lamb Co., Starrbaugh Bldg., Youngstown. Estimated cost, $125,000. Noted Aug. 11.

Rhode Island

PROVIDENCE — Brown University is having plans prepared for the construction of a 3-story, 50x200-ft. chemical laboratory. Chemical equipment will be installed in same. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., archts. and engrs.

Texas

EL PASO—The Atlas Brick Co., Dallas and Cotton Sts., plans to construct a lime hydrating plant, etc. Estimated cost, $60,000. Clarence L. North, pres.

PHARR—The city received bid for the construction of a sewage disposal plant including a septic tank from R. O. Langworthy, $20,000.

SAN ANTONIO — H. D. Kellar, Coldwater, Mich., plans to build a cannery and sirup mill here to include an ice factory, etc., for the manufacture of cane sirup, citrus preserves and marmalades.

Virginia

EAST RICHMOND (Richmond P. O.)—The Jefferson Tire & Rubber Co., Central Bank Bldg., is having plans prepared for the construction of a 3-story, 80x240-ft. factory. Estimated cost, $150,000. Akron Eng. Co., Akron, O., archt. and engr.

West Virginia

SCHINISTON—The Paquet Glass Co. is building an 80x120-ft. illuminating glassware factory. Estimated cost, $25,000. P. J. Paquet, pres.

Wisconsin

CAMPBELLSPORT — The White House Milk Products Co., West Bend, had plans prepared for the construction of a 2-story, 50 x 110-ft. condensed milk plant. Estimated cost, $75,000. M. Tullgren & Sons, 425 East Water St., Milwaukee, archts. Noted Aug. 11.

DURAND—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. H. Miles, secy.

Quebec

QUEBEC—The Standard Pulp & Paper Co., Ltd., will soon receive bids for the construction of a pulp and paper plant. Estimated cost, $1,250,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, on Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS 1920 annual meeting will be held in the Engineers Societies Building, from Dec. 7 to 10 inclusive.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.